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HANDBOOK

FOR

MILITARY ARTIFICERS,

PREPARED IN THE

ORDNANCE COLLEGE.

TENTH EDITION.

1915.

LONDON:
PRINTED UNDER THE AUTHORITY OF HIS MAJESTY'S STATIONERY OFFICE
BY HARRISON AND SONS, 45–47, ST. MARTIN'S LANE, W.C.,
PRINTERS IN ORDINARY TO HIS MAJESTY.

To be purchased, either directly or through any Bookseller, from
WYMAN AND SONS, LTD., 29, BREAMS BUILDINGS, FETTER LANE, E.C., and
54, ST. MARY STREET, CARDIFF; or
H.M. STATIONERY OFFICE (SCOTTISH BRANCH), 23, FORTH STREET, EDINBURGH; or
E. PONSONBY, LTD., 116, GRAFTON STREET, DUBLIN;
or from the Agencies in the British Colonies and Dependencies,
the United States of America and other Foreign Countries of
T. FISHER UNWIN, LTD., LONDON, W.C.

1915.

Price Ninepence.

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HANDBOOK

FOR

MILITARY ARTIFICERS.

SECTION I.

INSTRUCTION FOR CARPENTERS AND WHEELERS.

Care and Use of Tools.

Artificers should pay the greatest possible attention to the condition of their tools, and also to the manner of using them. When working, an artificer should always return his tools to their proper places as he finishes with them, for if left about on the benches they are liable to have their edges chipped and teeth damaged. More damage is often caused to tools by leaving them lying about carelessly than by actual wear.

After a piece of wood has been roughly shaped by axe or saw, the *jack plane* should be used to reduce it to the required thickness, and thus prepare it to be finished off with the *smoothing plane*, which should never be used upon rough surfaces.

Oil, raw linseed, should always be used on the faces of planes and spokeshaves; it preserves them and they work better.

Saws required to have their teeth re-cut occasionally, as taught during the wheeler's course of instruction. (*See* directions for saw-sharpening, page 7.)

Augers.

Augers are of two kinds, "shell" and "screw"; of the latter there are many varieties, some with square and some with round cutting edges. The "screw" is superior to the "shell"; the best of the former is one known as "auger, solid wing, eyed," owing to the lips of the cutting edges being attached to the main part and appearing as two round holes formed in the end, one on each side of the screw, which draw the auger on to its work. The screw augers are much quicker in their action than the shell augers, and if sufficient care is exercised in their sharpening, the tendency which they exhibit to "run" with the grain will be greatly diminished.

Bits for Carpenters' Braces.

A set of these bits consists of the following articles, viz. :—

Centre, $\frac{3}{8}$", $\frac{1}{2}$", $\frac{5}{8}$", $\frac{3}{4}$", $\frac{7}{8}$", 1", $1\frac{1}{8}$"	... ...	7
Countersink { flat	... ...	1
Countersink { rose	... ...	1
Dowling, sash, with collar	... ...	1
Gouge, $\frac{1}{8}$", $\frac{3}{16}$", $\frac{1}{4}$", $\frac{5}{16}$", $\frac{3}{8}$", $\frac{7}{16}$"	... ...	6
Nose, $\frac{1}{8}$", $\frac{3}{16}$", $\frac{1}{4}$", $\frac{5}{16}$", $\frac{3}{8}$"	... ...	5
Rimer, square	... ...	1
Screw-driver	... ...	1
Taper	... ...	1
		24

For men in possession of the carpenters' bits and augers, the use of gimlets is very limited, but there are positions in which a brace and bit cannot be applied, and a gimlet only can be used.

Gouge bits are used to bore holes across the grain of wood, but are not well adapted for boring endways with the grain.

Nose bits are similar in make to a shell auger, and are similarly used instead of the gouge bits for boring holes in hard wood and endways with the grain.

The *dowling bit*, with collar, is a nose bit of $\frac{3}{16}$ in. in diameter, and longer than any of the other bits, consequently it is suitable for boring deeper holes. The metal collar is useful to regulate its depth in boring, also to give it stability on account of its great length; but when the bit has been inserted about $3\frac{1}{2}$ in. the collar must be removed before a deeper insertion can be made.

Sharpening Tools.

Tools should be ground and sharpened to the best angle for the work required. Those for fine work, such as paring chisels, require a sharper angle (say about 14° on the grindstone brought down to 18° on the oil stone) than those for heavy work, such as coach-makers' chisels; these latter should be ground to about 25° and brought down to about 33° on the oil stone.

Chisels should be ground perfectly straight on the edge.

Oil stones should be left clean and used with Rangoon or sweet oil. Linseed oil is not suitable.

Grindstones.

In case of a stone being uneven it should be made level by grinding it with the straight part of an old file. When the stone is not in use it should be kept clear of water; allowing part of the stone to stand in water makes it soft on that part.

In grinding tools, the top of the stone should move towards the tool being ground, as if turned from the tool it would throw up a wire edge on it, and in grinding narrow tools, such as chisels, &c., they should be moved from side to side of the stone to prevent their hollowing it.

Planes.

The stocks of these planes are made of beech, with the felt running from the sole to the top, and are provided with a top iron, the object of which is to give rigidity to the cutter and prevent its running with the grain of the wood; the top iron is ground sharp, but only for the purpose of making it fit close to the cutter. The cutters are ground on one side only. A fine edge should be kept on the cutter by the oil stone. The edges should be ground straight and accurately at right angles to the sides, in order that they may work true in the stock; the bevel should also be kept straight in sharpening.

Jack planes are for general use; they prepare the way for trying and smoothing planes.

Trying (truing) planes are used for planing the edges of boards, &c., straight for jointing, also for planing flat surfaces.

Smoothing planes are used to give a smooth surface after a true surface has been obtained.

The *plough* is provided with eight irons varying in size from $\frac{1}{8}$ in. to $\frac{11}{16}$ in., and is used for making grooves, and by setting the iron in the required positions it can be used for ploughing, tonguing, and making match boarding.

Match or *grooving planes* are made specially for making match boarding; the irons are of different sizes, but smaller than plough irons, and are used by pairs, one forming the groove and the other the tongue.

Saws.

Saws are of a great variety, differing not only in the size and shape of the blade, but also in the size and shape of the teeth.

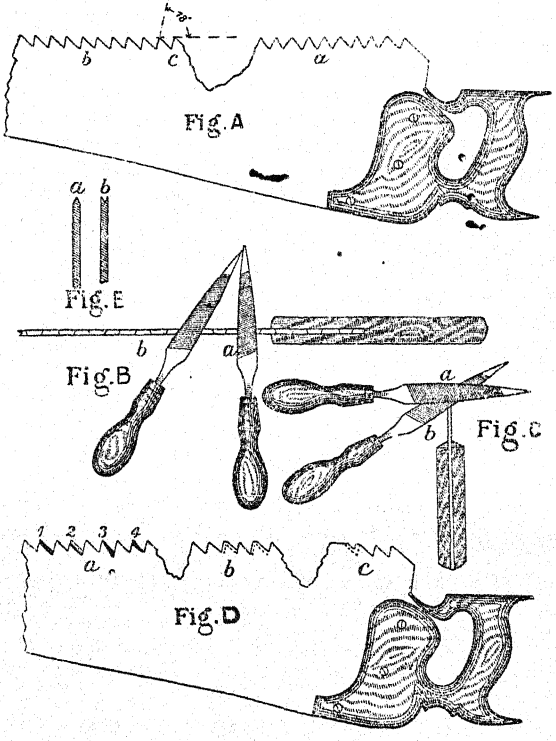
The blades of ripping, hand, and panel saws are of similar shape and dimensions, differing only in the size of the teeth, those in the panel saw being the finest, and those in the hand saw being a mean between the ripping and panel saws. These saws have a wide blade to give them strength, and are only adapted for sawing in straight lines; they have no back, which enables the whole blade to pass through a piece of wood.

The ripping saw is used for soft woods and rough work; the teeth being coarse, it is quick in its action.

The hand saw is used for general work where a fine cut is not required.

The panel saw is used where a fine cut is required, such as panels, &c.

The blades of tenon, sash, and dovetail saws are similar, differing only in their size. Their teeth are finer than those in the three first mentioned.


b
c
a
Fig.A
a b
Fig.E
b
a
Fig.B
a
b
Fig.C
1 2 3 4
a
b
c
Fig.D

Saw-sharpening.

The three commonest cases will be treated separately.

1. When the teeth simply require pointing to increase the cutting power.
2. When the teeth, owing to frequent pointing, become irregular (as shown in Fig. A at "*a*"), and require a more extensive adjustment.
3. When the teeth are so very irregular as to require entire removal and to be replaced by new ones.

1. Secure the saw in a vice between two strips of wood at a suitable height, and hold the file in such a manner that the plane of the cut made by the file exactly corresponds with the existing surfaces, first cutting the teeth on one side, then reversing the handle for the other side.

2. Fix the saw as before. Hold the file at right angles to the blade in both directions as shown at "*a*" and "*a*" in Figs. B and C, and cut through between each tooth until they are all exactly the same in size, independent of their relative heights, as shown at "*b*," Fig. A. This can thus be accomplished much better than by taking alternate teeth as in the last case. The cutting face of the teeth must be filed so as to fall backward about 12°, thus making an angle of 78° as shown at "*c*" in Fig. A, which is done by setting the bevel at the proper angle and testing the filing from time to time. This angle gives the best result for general work.

Next reduce the teeth to a common level, which is done by lightly rubbing off the higher points with a file run down the whole length of the saw, and carefully re-sharpening these, removing a portion from each side of the tooth, as shown by the dotted lines at "*b*" in Fig. D. This keeps the teeth the proper size, or as they were first produced. Several such runnings down will make a good even and level surface, which should be either straight or slightly convex, as the tendency is to wear the saw hollow.

To set the saw. This is done by bending the teeth alternately outward by the aid of a saw set, or, if it is done judiciously, with a punch made by breaking off the point of a worn-out file, tempering it and grinding it flat. The saw should then be held on the end grain of a piece of hard wood, and the punch struck with a light hammer. For a dovetail saw this is better than a set, as the smallness of the teeth is such that unless the set exactly fits the blade, the latter is likely to be bent and "crippled," instead of simply bending the tooth. This will occur with all saws if the set is too low down on the teeth.

If the timber to be cut is dry, very little set is necessary, as it increases the labour of cutting and wastes the material, but it is important that all the teeth have the same amount of set, and it must be remembered that inferior sharpening often leads to the mistaken idea that a saw requires more set.

It now remains to adjust the teeth to the proper angle for cutting, and here an angle must be given which will answer for all general

purposes, but which can be considerably altered to meet special cases.

Start with the handle of the saw on the right hand, and with the handle of the file 30° below the horizontal (*see* "*b*," Fig. C) and with about the same inclination toward the point of the saw (as shown in Fig. B at "*b*"), cut on the back of the tooth which is set away from the operator and which is nearest the handle. This cut should be as shown in Fig. D, where 1 and 2 are correct, and 3 and 4 are faulty. While this cut is being formed, a like cut is being produced on the front of the tooth immediately behind this one, and the two surfaces should be so cut that when one of them is completely bevelled, the other is in a like condition, and it is necessary for the whole of the squareness to be removed to ensure good results. The mode of treatment of one of these hollows between two teeth is the same for all the others. Alternate hollows are dealt with on one side of the saw, and then on the other.

If properly done, the cross section will appear like "*b*" in Fig. E. A needle laid in the channel between the teeth should traverse the whole length of the saw on raising the handle.

3. When the teeth of the saw are in a very bad condition, it is quicker to remove them entirely, and replace them with new ones.

To do this :—File off the old teeth so that the surface of the blade is perfectly clean, and start the cutting from the handle end.

A half rip saw requires about 2 teeth to the inch.

„ hand	„	„	„	4	„	„	„
„ panel	„	„	„	8	„	„	„
„ tenon	„	„	„	10	„	„	„
„ dovetail	„	„	„	16	„	„	„

Thus the division of an inch by these numbers gives the space each tooth should occupy.

Taking the hand-saw as an example : Cut the first hollow $\frac{1}{4}$ of an inch wide, and the extremity nearest the point of the saw will represent the point of the first tooth. (*See* "*c*," Fig. D.) Now start another hollow a little distance from the intended point, as shown, and gradually work back to the handle end as denoted by the dotted line, thus forming the tooth immediately behind. When this is done, the hollow can be made $\frac{1}{4}$ in. wide as before, and the process repeated until all the teeth are cut in, when the directions given in Process No. 2 can be applied to complete the operation.

The teeth had better at first be measured to ensure that they are all of the same size.

NOTES ON TIMBER.

Upon examining a freshly cut section of any timber tree the wood is found to be arranged in the following manner :—

In the centre is the pith and round it are a number of concentric rings, becoming larger and larger in diameter as they approach the

outside of the tree. These rings are usually formed at the rate of one a year, and are therefore called Annual Rings.

In some trees—the oak for example—there are thin lines to be seen, radiating from the centre towards the bark; these are called Medullary Rays.

At first the rings are full of sap, moist and soft, but as the tree becomes older the rings nearest the heart become hardened. These hardened rings increase in number year by year till nearly the whole tree is composed of hard rings called Heart Wood. The outer layers are termed Sapwood. The sapwood can usually be distinguished from the heart wood by its lighter colour.

Most sapwood is unfit for constructional purposes, as it is weaker and more liable to decay than heart wood. The War Department usually specify that all timber shall be free from sap, *i.e.*, that all sapwood shall be removed from it.

The different kinds of timber commonly used for building and engineering work may be divided into the following classes :—

Soft woods, as Fir, Pine, Spruce, Larch, and all cone-bearing trees.

Hard woods, as Oak, Beech, Ash, Mahogany, Teak, and Greenheart.

Appearance of Good Timber.

There are certain appearances of good timber of any class. In the same species of timber, that specimen in which the annual rings are the densest and contain the least amount of porous wood will, in general, be the strongest and most durable. The heaviest specimens are usually the strongest. Where there are medullary rays they should be hard and compact.

The woody fibre between the rays should adhere firmly together and show no woolliness at a freshly cut surface. It should not clog the teeth of the saw with loose fibre.

In coloured woods darkness of colour is a good sign.

A fresh cut surface should be firm and bright; a dull, chalky surface is a sign of bad timber.

Spongy places should be looked for and timber containing them avoided.

Defects in Timber.

Timber is liable to the following defects :—

Knots where branches go off from the tree. This is, perhaps, the most serious, as it is the commonest defect.

Heart-shake consists of clefts starting from the centre of the log and extending outwards. They are usually widest at the centre of the log, and tend to split the butt into segments. It occurs in old trees, and the central parts of the stem may show signs of hollowness with radiating cracks running out more or less into the younger layers. Star-shake consists of clefts radiating from the centre, but there is no hollow. The clefts usually widen as they run outwards. It may occur in trees of any age.

Cup-shake is a separation between the annual rings. It is not very common in ordinary timber, but is rather prevalent in lignum vitæ.

Foxiness. Trees after felling are often found to be decayed at the heart, the decay being sometimes so far advanced as to render them rotten or hollow. In this case the affected parts are either white or yellowish red in colour. If white, the defect is usually but slight and does not extend more than a few feet up the stem. If yellowish red, it is frequently of a more serious character, and if tested with a small auger may often be traced half the length of the tree. When the affected parts have assumed a decidedly red tinge the tree is said to be "Foxey," and is then nearly always useless.

The Seasoning of Timber.

The term "Seasoned" is applied to timber which is fit for carpenter's work. The term dry timber is applied to timber that has lost one-third of its weight. This takes four years and it is then fit for joinery.

Seasoning consists in driving out the water the timber contains. If this water be shut up in the timber, decomposition takes place. The best way of seasoning is by stacking the timber in a dry place. It should not be allowed to lie on the ground, and, while perfectly protected from the weather and draughts, should be exposed to a free circulation of air. The ends should be carefully guarded from the sun.

There are two or three ways of artificially seasoning timber, the object being to hasten the process. These are :—

Water seasoning. This is the best, and consists in immersing the timber for about a fortnight and then stacking it as before.

Steaming or boiling. The timber is either steamed or boiled for about four hours and then stacked.

Desiccating. This consists in exposing the timber in an oven to a current of hot air which dries up the sap. This takes a few weeks, the time depending on the size of the timber.

Artificially seasoned wood should not be used for any but rough work if it can be avoided.

Decay of Timber.

Dry Rot.—This is caused by moisture and want of circulation of air. It destroys the strength of the wood, makes it soft and brittle, and eventually reduces it to powder. It can be prevented by seasoning, ventilation, and avoidance of moisture.

Wet Rot.—This is a similar disease, but occurs only in the growing tree.

Preservation of Timber.

The two great preservatives are seasoning and ventilation. Painting preserves timber if it be thoroughly seasoned and dry, otherwise the paint only confines the moistures and hastens decay. Charring or tarring the ends of posts or timber buried in the ground keeps the wood from rotting.

Special methods of preserving wood are :—

Creosoting.—This is done by extracting the air and moisture from the pores of the timber, and then forcing in creosote (oil of tar) at a high pressure. About 10 lbs. of creosote are used per foot cube of wood.

Kyanising consists in filling the pores with corrosive sublimate. It is more expensive than creosoting and is seldom done.

Vulcanising or Haskin's process.—This consists in, as it were, drying up the natural juices of the timber by heated air and so preserving the wood. It is the most recent process.

Storage of Timber.

The following points should be noted for guidance in storing timber :—

1. The slats must be perfectly sound.
2. No rotten or worm-eaten wood may be kept lying about anywhere in the store.
3. Stacks should not be too large, but should allow of careful inspection of any piece in the stack.
4. The height of the stack should be arranged so as not to have too much weight on the bottom layers. This is specially important with soft woods.
5. A clear space of at least three feet should be allowed from the walls of the store.

PROPERTIES AND USES OF TIMBER.

Soft Woods.

Red Fir.—This timber is chiefly imported from the Baltic. The pieces are classified into baulks, planks, deals and battens. Baulks are roughly squared logs or beams, varying in dimensions with the class of timber. Planks are pieces of 11 inches broad, and from 2 inches to 6 inches thick, any length. Deals are 9 inches broad, but not more than 4 inches thick. Battens are 7 inches broad. Planks, deals and battens of Red Fir are commonly known as Red or Yellow Deal.

Appearance.—The colour is a reddish yellow. The annual rings are strongly marked, one part of each being soft and light-coloured, the other part being harder and dark-coloured. There are no medullary rays. The freshly cut wood has a strong resinous smell and taste. The best kinds have thin annual rings.

Properties.—Tough and elastic, durable if well seasoned, easily worked.

Uses.—For carpenter's work on a building, often for joiner's work also. It is particularly good for roofing and framed work of every description.

Red Pine.—Appearance.—Reddish-white colour, straight grain, smooth and silky to work and contains but few knots.

Properties.—Not as strong as Baltic red fir, durable when the air has free access to it, takes well to glue and does not warp.

Uses.—Chiefly for cabinetmaker's work and for veneering.

Yellow Pine (American).—Appearance.—White coloured when freshly cut, but brownish yellow when seasoned. Free from knots, soft surface with short detached dark hair lines running along the grain. The annual rings are not distinct.

Properties.—Very soft, easily worked, adheres well to glue, but takes nails badly.

Uses.—Invaluable for joinery, mouldings, patterns, &c., on account of the great width in which it can be obtained. This makes it specially valuable for panels.

Pitch Pine.—Appearance.—Very close regular grain with annual rings. Reddish colour, full of thick resinous matter, free from knots, feels sticky.

Properties.—Heavy, hard to work, often shaky, sometimes the turpentine has been tapped and this makes the wood brittle.

Uses.—Makes strong timbers for heavy work, also durable treads for stairs, floors, window-sills, framing and joinery generally, is specially used for work that is to be varnished instead of being painted.

White Fir or Spruce.—Is not quite so good as red fir. It is imported in the form of young trees for scaffold poles, and in planks, deals and battens from the Baltic and Russia. Imports from the White Sea make a fair substitute for the more expensive Red Fir, as the timber can be obtained comparatively free from knots.

Appearance.—The wood is much whiter than that of the red fir and the annual rings are not distinctly marked. The sap is scarcely distinguishable. The knots are hard and glassy, and become loose when the wood is dry.

Properties.—Tough, easily worked, warps very much, is inferior in strength and soon decays.

Uses.—For packing cases and inferior work.

American Spruce.—This is of three kinds, the white, black and red. It is lighter, tougher and usually contains less knots than Baltic Spruce. Its uses are the same as Baltic Spruce and in addition is largely used for tent poles, owing to its freedom from knots.

Larch.—Properties.—Tough and durable, but liable to warp.

Uses.—For posts, pailings, &c.

Hard Woods.

Ash.—Appearance.—The medullary is not very pronounced. The sapwood, of which there is often only a very small amount, varies but slightly in colour from the heart-wood, but it is softer and less durable.

Properties.—Tough and durable if well seasoned and felled in winter, otherwise very perishable. It is an elastic wood. It should not be exposed to damp, nor to alternate wet and dry. Logs should be cut up at once or they will split.

Uses.—Handles for picks and shovels, shafts, felloes of wheels.

Beech.—Appearance.—Brown in colour, hard, close in texture and very fine in grain. The medullary rays are very distinctly marked.

Properties.—Easily worked, durable when dry or when constantly wet, but soon destroyed by damp.

Uses.—For piles, mallets, handles of chisels, planes, &c.

Elm.—Appearance.—The wood is a dull reddish-brown, tough, and so twisted in grain that it is impossible to split it. The sapwood is yellowish.

Properties.—Most durable when worked up as soon as possible after felling. If stored it should be kept under water or in mud. It twists and warps in drying, and shrinks very much. It is difficult to work, but does not split, and bears the driving of nails and bolts better than any other wood.

Uses.—It is extremely useful for piles, blocks, pulleys, &c., also for naves of wheels.

It should be noted that it is extremely liable to the attacks of worms, and that if used in situations where it is not exposed to alternations of wet and dry it excels most kinds of wood in lasting qualities, but that under other circumstances it decays with great rapidity.

Oak.—Appearance.—Pale brown in colour, hard and compact, with distinct annual rings and medullary rays. The medullary rays of the best oak are small, and the annual rings hard and compact. Many large pores, a dull surface and a reddish hue are signs of inferior wood.

Properties.—Oak is the most durable of all known woods. It is apt to shrink and warp in seasoning, and so cannot be used in a partly seasoned state, but when once its moisture is completely evaporated few woods are so little affected by alternations of wet and dry.

Uses.—For sills, treads of steps, posts, trenails, felloes, &c.

Teak.—Appearance.—Brown coloured, even and clean in grain, and contains a resinous oil which prevents iron fastenings from corroding.

Properties.—Light, easily worked and splits freely; requires but little seasoning, and shrinks but little. It is subject to heart-shake, but tolerably free from other defects. Frequently it is worm-eaten, the holes being from $\frac{1}{4}$ to $\frac{1}{2}$ in. diameter, and then is invariably brittle. Such wood should be rejected.

Uses.—As backing for armour plates, and to a less degree for similar purposes to those mentioned for oak.

Mahogany.—Appearance.—Honduras or Bay Mahogany. This is a red-coloured wood, the grain being clean and straight. It is the one in most common use. Spanish mahogany may be distinguished from it by a white chalky substance which fills the pores of the latter.

Properties.—Very durable if not exposed to the weather, works easily, but requires great care in seasoning.

Uses.—Chiefly for handrails and ornamental purposes.

Greenheart.—Appearance.—Fine grain, full of small pores, annual rings not distinguishable, heart-wood a deep chestnut and the sapwood a pale yellow.

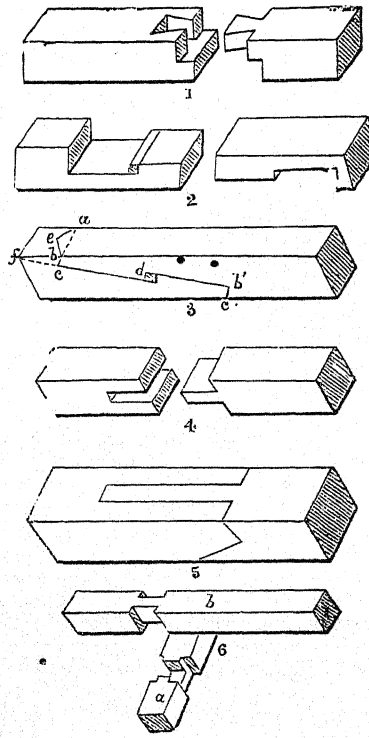
Properties.—Full of oil, very durable under water, very free from attacks of worms, strong, but containing much sapwood.

Uses.—For heavy work; for example, fender piles, wharf work, &c.

Jointing Timbers.

Lengthening Timbers.—Figs. 1 to 5 represent different ways of lengthening timbers. It is not absolutely necessary to scarf the

Figs.



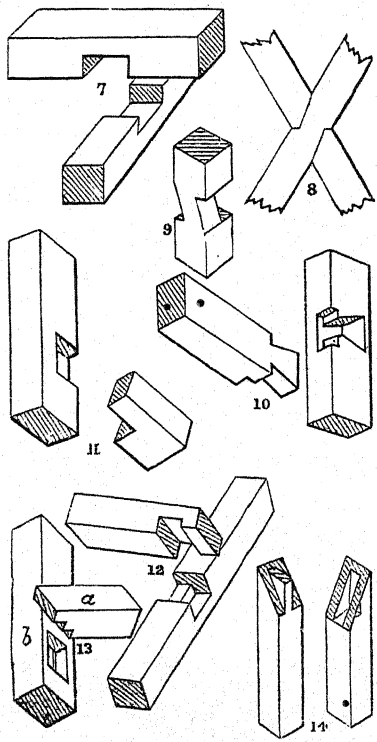
point as shown (by *a e b*) (Fig. 3), it is frequently finished as shown by the straight line (*a b*) (particularly when iron plates are to be riveted on the sides); the angle (*b f c*) is generally about 20°. A key is driven in from each side at (*d*) to thoroughly close and tighten the joint. The keys should be made slightly tapered and to fit accurately.

This joint (Fig. 3) is used for splicing spars for sheers, derricks, cranes, &c., by strengthening the joint with an iron plate riveted on each side. A good butt scarf, suitable for vertical use, may be formed by making it straight from *c* to *b'* and using no keys.

Fig. 5 represents a joint formed by a tongue with a *sally*; the tongue should be cut so as to stand vertical.

Crossing Timbers.—Figs. 6, 7, 8, and 9 represent the most common methods of crossing timbers by means of halving so that they may

Figs.



be the same thickness at the joint as one of the timbers; they will have only half their original strength. When the top and bottom surfaces are not required to be flush, advantage should be taken to make the housing as shallow as possible.

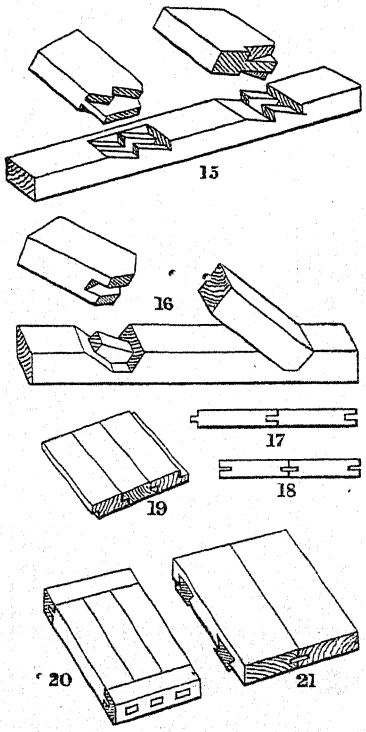
Fig. 9 is another view of one of the parts shown in Fig. 8.

Figs. 10 to 14 represent five different methods of jointing timbers when they are not to cross.

Mortise and Tenon.—Fig. 13 represents the common mortise and tenon which is used with heavy framing, when the bar (*a*) is thinner than the side; this necessitates the shoulder being formed on one side only. It is used in the framing of the sides and bottoms of wagons and carts, framed shafts, &c. The side (*a*) of the bar should, as far as possible, be situated on the side opposite to that receiving the greatest pressure.

When the framing is of the same thickness all round, as in the case of the sides, summers, and earbeds of wagons, the tenon must

Figs.



be shouldered on both sides to throw the mortise in the centre. These tenons are tapered, and secured with a tapered oak pin placed vertically through them.

In the lighter descriptions of frames, such as those used for doors, &c., the tenons have not a second shoulder formed on them as shown in Fig. 13, and are not secured with pins, but by a wedge on each side of the point put in with glue, and the outside of the mortise is enlarged for the reception of the wedges. These tenons are not tapered, and are $\frac{1}{3}$rd the thickness of the rail, being shouldered on both sides.

Fig. 14 represents another form of the mortise and tenon.

Figs. 15 and 16 represent three different oblique mortises and tenons which are principally employed in building.

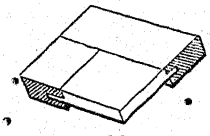
Jointing Boards.

Ploughing and Tonguing.—Figs. 17, 18, and 19 represent three different methods of jointing boards; in all such operations it is absolutely necessary that the edges be perfectly straight and square before a good joint can be effected.

In Fig. 17 the thickness of the tongue is one-quarter of the thickness of the board.

In Fig. 18 the tongues may be made of either wood or hoop iron: when they are made of wood they should be about $\frac{1}{4}$-in. thick for heavy boards, and when strength is required they should be cut

Figs.



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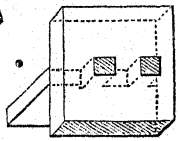

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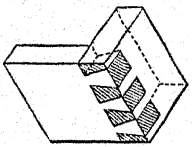

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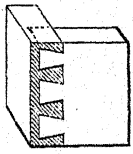

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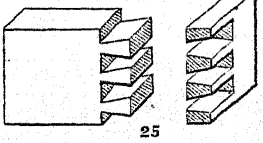

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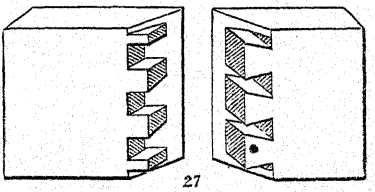


27

with the grain of the wood crossing diagonally the junction of the boards; the tougher the wood the better. If the tongues are not glued in they should be well coated with white lead.

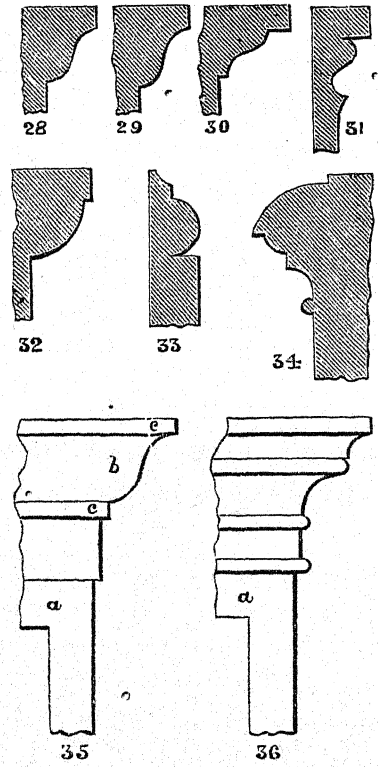
Rebating.—Fig. 19 represents a method of jointing by "rebating." The joints of boards are generally improved by a bead, and with

boards which have been rebated it should be on the side away from the rebate.

Figs. 20 and 21 represent two different methods of clamping the ends of boards, the object being to prevent them warping. Fig. 20 shows a method of effecting this by ploughing the clamping pieces and tonguing the ends of the boards with mortises and tenons formed at intervals.

In Fig. 21 the clamping is effected by making a dovetail notch across the underside of the boards near each end and forcing in a "rabbet."

Figs.



Framing and Panelling.—Fig. 22 represents a portion of a panel in a frame sunk on one side and flush on the other.

Fig. 23 represents a method of jointing boards at right angles; it is simply the mortise and tenon.

There are three different kinds of dovetailing, viz., common, lap, and mitre.

In dovetailing the ends of a deal box of about 2 ft. square, in the end the pins should be about 2 in. apart, and for 1-in boards, the pins should be about $\frac{7}{8}$ in. at the back and $\frac{1}{2}$ in. in the front. For hard woods the pins are closer together and smaller. It will generally be found best to make the pins first and mark off the notches by them. The surface, if not clean, should be chalked over and the pins and notches marked out with a fine pointed pricker.

All jointings by dovetailing, mortising, housing, &c., should be put together with either glue or white lead ; if the article is likely to be exposed to moisture it should not be glued, as the glue would become soft and entirely lose its strength.

Mouldings.

Mouldings are chiefly used for purposes of ornament ; there is hardly any article constructed in the mechanical arts, let it be ever so simple, but its appearance is improved in some way by mouldings ; they are of a great variety and are employed according to taste.

The Figs. 28 to 34 represent the most simple kinds of moulds which are in common use, with their names.

Figs. 35 and 36 represent simple mouldings such as are generally applied to the top of a press, cupboard, book-case, &c.

Some taste is required in selecting moulds suitable for the article to which they are to be applied.

Fig. 28.—"Cyma Recta."
„ 29.— „ „
„ 30.—"Cyma Reversa."
„ 31.— „ „
„ 32.—"Ovolo."
„ 33.—"Torus."

Fig. 34.—A specimen of Gothic moulding.
Figs. 35 and 36 show application of mouldings to ornament top of cupboards, presses, &c.

Doors.

Doors used about buildings are of great variety, but the following represent those of a more simple kind, and which are in most general use.

Fig. 37 represents a barred or ledged door ; it is generally used about outhouses, and is constructed as follows :—

The edges of the boards are rebated together, beaded at the junction of the boards on both sides of the door and nailed to transverse pieces termed bars or ledges. In this case the boards are not glued together.

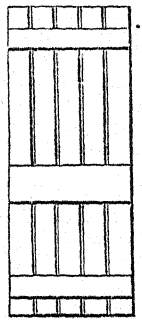
Door posts are rebated to receive the doors when closed, and the rebate is generally formed by nailing a fillet on the post.

Fig. 38 represents a panel door ; the parts are named as follows :—

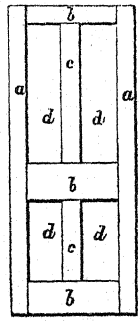
(*a.*) Stiles.
(*b.*) Rails, top, middle, and bottom.
(*c.*) Mountings.
(*d.*) Panels.

Figs.

37.



38.



The rails are tongued into the stiles, and the mountings are tongued into the rails; the stiles, rails, and mountings are grooved on the edge to receive the panels.

The middle and bottom rails are wider than the top rail; this is necessary to strengthen the door against dropping, and is also a convenience for fixing the lock and handles.

Making a Wheel.—It is possible for a man to make a good wheel from patterns of spokes and felloes supplied, and yet be ignorant as to the mode of arriving at the construction, and such a man left to his own resources would entirely fail on this account. A general outline, without entering very much into detail, is given of the mode of making by hand the above-named wheel with metal nave; and although a man may not often be required to make all the spokes and felloes for a new wheel, the same principles are involved in making one felloe and spoke, as there are in making more.

The method of operation is similar with the other natures of wheels, the principal difference being in the dimensions of the material employed.

The nave of "metal" being cast, a description of its manufacture is omitted.

The pipe-box is of phosphor-bronze with the usual grease-chamber, grooved at the bearings to facilitate lubrication, and is secured from turning round in the flanges by an iron feather let into it, which enters the back flange. It is marked P.B. on the front face.

The first pipes that were made were not of phosphor-bronze, but merely of a hard description of (roller) metal, and consequently were more liable to score than the present pipes, and they were not grooved on their bearings.

The flanges of the nave are set so as to give a dish of two inches in the distance from the axis of the nave to the bosom of the felloe.

Spokes.—English or African oak is employed for the spokes,* great strength being required. When English oak is used (which is

* In the absence of English oak, Greenheart has been used for spokes for wheels of Transport vehicles.

Fig. 39.

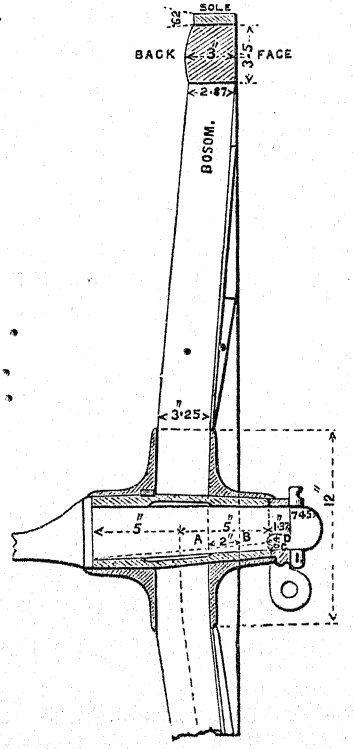


Fig. 40.

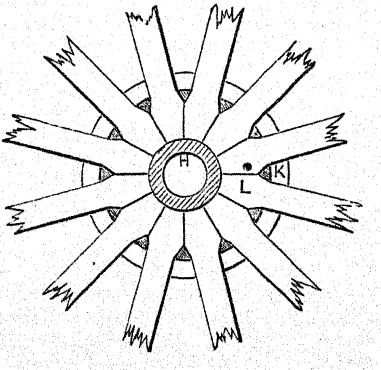
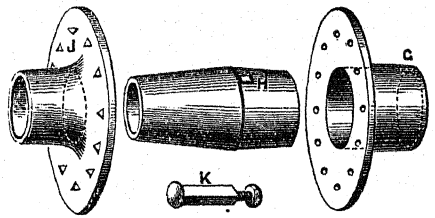


Fig. 41.



the rule) the wood is specially selected, namely, that straight in the grain, free from knots, shakes, and sap, and is cleft with the felt running from back to face of the spoke.

Nomenclature.

H Pipe-box.	L Spokes.
J Front flange.	D Tongue.
G Back flange.	T Tang or Tenon.
K Nave bolt.	

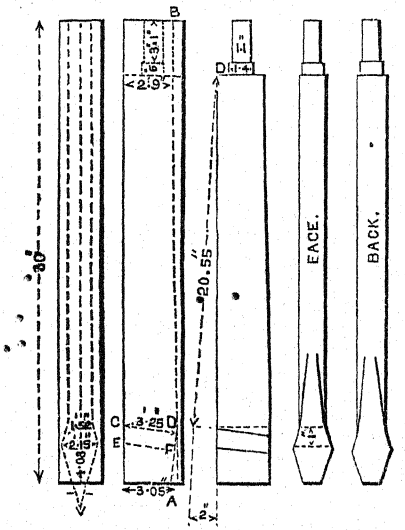
The dimensions of the spoke in the rough is about 30″ × $3\frac{3}{4}$″ × $2\frac{1}{4}$″, and it is shaped as follows :—

1. Make one edge perfectly straight and smooth to form the face of the spoke.
2. Draw lines on the face as indicated in Fig. 42.
3. On one side of the spoke draw the line A D B shown in Fig. 43.
4. Reduce the wood to the line with the saw and make it straight and smooth to form the back of the spoke.
5. Draw the shoulder lines C D, E F, Fig. 43, across one side, and continue them across the back.

These lines are parallel to the axis of the nave, but are sloped on the spoke in consequence of it being dished.

6. Draw lines on the back similar to those on the face, and continue the centre lines across each end, in order to get the centres exactly opposite.
7. Reduce the spoke to the outside lines, but leave the shoulders a little full from E to a little above C, until after the wheel has been shod.
8. Draw lines across the sides at the shoulder to indicate their exact position.
9. Draw the position of the tongue and tenon as shown in Fig. 43, the shoulders being parallel to the shoulder lines of the foot, because the bosom of the felloes is made to be parallel to the axis of the pipe-box, and the tongue must then be perpendicular to the shoulders in order that it may run through the centre of the felloe. The shoulder should be marked on all sides of the spoke, but the tongue only on one side and face.
10. Form the tongue by removing the superfluous portions with the saw and chisel, and neatly round it with a file.

Figs.
42 43 44 45 46



11. Dress the spokes with planes, spoke-shave and glass paper, to the form as shown by Figs. 45 and 46, making it about $\frac{1}{16}$ inch thicker down the back than the face.

12. Slit the tenon of the spoke across the centre with the tenon saw about 1 inch down to receive an oak wedge.

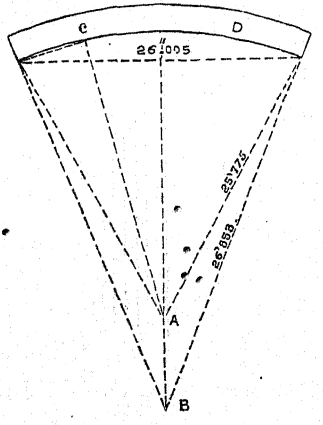
After making one spoke in this manner, gauges may be made to mark out other spokes by.

Felloes.—On account of the elasticity required in the felloes, they are made of ash or walnut, and are cut from a plank of not less than $3\frac{3}{4}$ inches in thickness, and with the grain running lengthways as much as possible.

There is a little peculiarity about a felloe; it is struck out with a larger radius than that of the wheel, which is necessary in consequence of the liability of the ends of the felloes to droop, both in shoeing the wheel and in use afterwards. The striking-out radius for the bosom of the felloes is greater than it should be for the size of the wheel by $\frac{1}{2}$ inch for every foot in the radius of the wheel, and thus in the 9-pr. wheel, which is 5 feet in diameter, equals 26·853 inches. This is found as follows:—the radius of the felloes, supposing no increase made in it, equals the radius of the wheel ($2' = 30''$) less the thickness of the felloes ($3\frac{6}{10}''$) and the thickness of the tire ($\frac{5}{8}''$) or $30'' - 4''{\cdot}225 = 25''{\cdot}775$, but this has to be increased

in the proportion of $\frac{1}{2}$ inch for every foot; therefore, if x be the required increase, we have the proportion $12'' : \frac{1}{2}'' :: 25{\cdot}775 : x$ and $x = \frac{\frac{1}{2}'' \times 25{\cdot}775}{12} = 1''{\cdot}078$, and hence the striking-out radius $=$ $25''{\cdot}775 + 1''{\cdot}078 = 26''{\cdot}853$.

Fig. 47.



In Fig. 47, A represents the centre of the wheel, and B the striking-out centre.

1. Strike out the felloe as follows:—Take a straight lath, and place two bradawls in it, 26·853 inches apart, and use it as a scriber to mark out the bosom of the felloe; pivot it by one awl on a piece of wood on a level with the plank, and describe an arc with the other awl on the plank, such that its chord be not less than 26·5 inches. From the same centre describe another arc about 4 inches from the first to form the sole of the felloe, by first removing the scribing awl 4 inches farther from the pivot. Then mark the ends by the lath, still keeping the latter pivoted, and not forgetting that the distance or chord between the ends must as already mentioned be 26·5 inches, which is a little too long to admit of adjustment in putting the wheel together.

2. Make about three incisions from the edge of the plank to near the inner curve with the hand saw, dividing the chord about equally in four parts.

3. Cut the felloe out of the plank in the rough along the back line with the "turning" saw, cut the ends with the "hand" saw, and remove the material to near the inner curve with the adze.

4. Face one side of the felloe with the "jack" plane, and clean out the bosom square to the faced side with a spoke shave; test it with the "square."

5. Mark off the width, $3\frac{1}{8}$ inches, of the felloe with the single tooth gauge, along the bosom and sole from the faced side, $\frac{1}{8}$ inch being thus left to allow for any error in working, but to be subsequently removed.

Reduce the width to these lines with axe and jack plane.

6. Mark off the length of the felloe, making 26·005 inches long in its chord, using the striking-out centre as before to draw the lines across the face for the ends;* this ensures a close joint from the bosom to the back when the wheel is shod.

* Be careful that each end of the felloe is of equal distance from the striking-out centre.

The radius of the bosom of the felloes, supposing no increase in it as before mentioned, is 25·775 inches, and therefore there being six felloes in the circle, the chord of each should be the same, 25·755 inches, but the striking-out radius of the felloes being greater than 25·775 inches, it necessitates the chord being 25·88 inches, to which must be added $\frac{1}{8}$ inch to allow for compression of the wood at the joints and inward movements of the felloes in shoeing, making the total length of the chord = 25·88″ + ·125 = 26·005 inches. Cut the ends with a tenon saw and plane them.

7. Draw a line along the centre of the bosom and sole, and divide the bosom into four equal parts with the compasses, and draw a line across the bosom with the square through the outside points (C D). Place the felloes in a circle, and, with a lath, using the centre of the wheel as centre, draw a line across the face of the felloe from the lines to represent the centre of the spoke hole ; continue the line across the sole to serve as a guide in boring.

8. Bore the holes for the large part with a centre-bit, and for the small part with an auger, and enlarge the holes about $\frac{1}{8}$ inch on each side on the sole, lengthways of the felloe, to allow the wedges, when driven into the tongue, to open the latter, and thereby wedge it firmly.

9. Mark the centre of each end of the felloe, and bore a 1-inch hole with an auger about $1\frac{5}{8}$ inches deep, square with the end of the felloe for the dowell.

10. As the sole of the wheel is only $2\frac{1}{2}$ inches when finished, take off about $\frac{3}{8}$-inch of the back at the sole, rounding it to nothing near the centre.

11. Paint the ends of the felloes to exclude moisture.

12. Insert a dowell of oak 1-inch in diameter, and 3 inches long in one end of each felloe.

13. Form the other felloes in a similar manner, marking them out so as to economise material.

Instead of marking each one out as detailed for the first, it will be found more convenient to use a wooden mould made by the first.

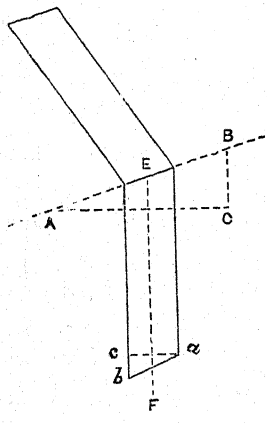
To put the wheel together.—First place the spokes in the felloes, and wedge them up tightly ; lay the felloes with the spokes in them on the ground ; insert the dowels, as far as possible, evenly all round ; make any adjustments that are necessary at the joints ; take the pipe out of the back flange carefully, and assist the closing of the joints of the felloes by bolting on the flanges, without the pipe, with small bolts such as tire-bolts, as there is not room for the nave-bolts.

The total amount of the openings in the joints of the felloes should not exceed $\frac{5}{8}$-inch before shoeing.

15. Plane the sole all round, reducing the felloe to 3·7 inches at the back, and 3·6 at the face, thus leaving $\frac{1}{10}$-inch for waste in burning, and to allow for compression by the tire in shoeing.

16. Bevel the sole in order to give it an even bearing on the ground when the wheel is on its carriage which the "hollow" of the axletree arm would otherwise prevent its having; the amount of bevel equals $\frac{1}{10}$-inch, that is to say, the felloes are $\frac{1}{10}$-inch thicker at the back than the face.

Fig. 48.



This is found as follows—

The sole, before bevelling, is parallel to the axis of the nave. If, in Fig. 48, A B represent the length of the pipe box, and E F the perpendicular to the ground when the wheel is on its axle, and lines be drawn from A, a perpendicular to E F, and from B, b parallel to E F, two similar triangles A B C, a b c will be formed, and therefore A B : B C : : a b : b c. But A B, the length of the pipe box, is 10 inches, B C, the hollow of the arm, is $\frac{4}{10}$-inch, and a b, the width of the sole, is $2\frac{1}{2}$ inches, A C being parallel to the ground,

therefore $10'' : \cdot 4'' : : 2\cdot 5'' : b\ c$ and $b\ c = \frac{4}{10} \times \frac{5}{2} = \frac{1}{10}$.

The wheel is then ready for shoeing, and the tire being a ring tire is put on by the smiths, assisted by the wheelers, as detailed at page 46.

After the wheel is shod it is finished off as follows :—

1. Bolt on the tire, cutting off the superfluous portion of the inner ends of the bolts, and clean off the felloe to the tire.

2. Round off the sharp edges of the felloes along the bosom to enable them to throw off the mud and prevent splintering.

3. Fit the nave by placing a wood plug in the centre, and from the exact centre of the wheel, front and back, describing circles, respectively equal in diameter to the front and back of that part of the pipe box which lies between the flanges.

4. Cut the ends of the spokes very neatly away to these circles.

5. Insert the pipe from the back, and bolt up the flanges, making any little adjustments required to admit the bolts.

6. Fill in the interstices over the bolts with elm to exclude moisture from the feet of the spokes, nailing the bits to the spokes with two $1\frac{1}{4}$-inch brads on each side.

SECTION II.

INSTRUCTION FOR SMITHS.

In this section a general outline of elementary instruction is given in smith's work, passing on to a description of some of the more difficult forgings which may be executed by the field forge, with examples on the management and application of steel, also in brazing, soldering, and the application of plastic metal.

To produce first-class work a smith must be master, 1st of the fire, 2nd, of the tools he uses.

Fires.

Fires are made to suit the various purposes for which they are required.

Loose fire.—A "loose" or "open" fire is suitable for general work, and should have a 5-inch breast between back plate and edge of fire. During work the sides of the fire are drawn towards the centre as required, the spaces being filled by fresh coal and flattened down with the slice. In this way a good fire may be kept without spreading and wasting fuel.

Stock fire.—"Stock" fires are those which stand the required distance from the nozzle, and are made by placing a bar of round iron or a piece of wood in the nozzle with fine wet coal well rammed down heaped over the bar close up to the back; when the bar is withdrawn a channel is left for the blast. Stock fires are used for special work only.

Hollow fire.—When it is required to heat anything equally over a great length, as in the case of the plate of a steel spring, it is best to make what is termed a "hollow fire," which is formed by first making a stock fire, and then placing a piece of wood of about 3 or 4 in. square in section across the front of the nozzle, and about 6 in. from it, and building up fine wet coal over it, which is rammed down hard; the bellows are then worked gently until the wood is burnt out, leaving a hollow fire, which may be fed as required with a little coal or coke. If fire bricks are available, a hollow fire made with them is preferable.

If a fire has been used for burning paint off ironwork, or for heating galvanized iron, it must be cleared out and a fresh one made before good sound welds can be effected, as any lead in a fire is fatal to good welding.

Fuel.

Either coal, coke, charcoal, or breeze may be used. If coal is not obtainable the ashes from a wood fire (*see* pages 40 or 44) may be used. A large fire should be made at first, as this fuel burns freely. A tire can be welded in this way.

General Instructions.

Good iron and mild steel for smith's work should be able to stand the following tests. (*See* paragraph (Mild Steel), page 47.)

A small bar is tested by being bent up sharply when cold, which it should stand without cracking, and by bending it backwards and forwards until it breaks, when it should exhibit considerable toughness. Common iron will exhibit less toughness, but it should bend without breaking, and weld soundly.

The hot test consists in heating the bar and punching a hole near the edge; if the iron is bad it will burst out at the side; it is also cut open at the end, and the arms bent back, which it should stand without cracking.

"Upsetting" consists in heating a piece of iron at some particular part, and driving the adjacent portions towards it so as to increase the thickness of the heated part.

"Drawing out" consists in heating a piece of iron at some particular part, and striking that part so as to decrease its thickness and increase its length.

"Cleaning off" is working up a smooth surface after forging, which is generally done by using the flatter, rounding tools, &c. The tools should be dipped in water when finishing, which will facilitate the removal of the scales of oxide of iron.

"Scarfing" is bevelling the end of a piece of iron, an operation necessary to ensure good welding; *see* Fig. 54 and rule for scarfing.

Articles made too large at first.—It is a principle in forging to make articles at first a little larger than the required size, which is necessary on account of the iron wasting under operation, and in finishing the article it is worked down to the proper size.

There are two qualities of wrought iron used in the service, and known as I.C. No. 2, and I.C. No. 3. It is supplied in rods or bars 12 ft. long, and in plates 6′ × 2′ or 5′ × 2′.

Steel Mild *I.C. No.* 6 is used for repairs and smith's work in general. Iron *I.C. No.* 3 is for boiler work and articles subject to great strains, necessitating higher quality.

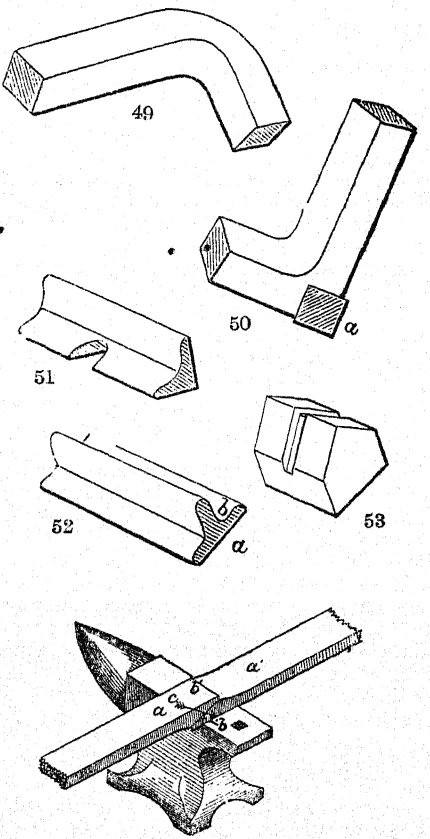
Heats.

Heats are spoken of as "welding heat," suitable for "welding"; "white heat," for upsetting, drawing out and shaping; "dull red heat," for expanding a ring tire, &c., or for shrinking ironwork on to woodwork, such as sockets on swingletrees, splinter bars, hoops on wood naves, mauls, &c.

How to take Heats.—In taking heats it is of great importance not to burn the iron; it may be burnt and wasted on the outside before it is properly heated through if it is a thick piece; to avoid this, blow steadily, which will prevent fusion on the outside and allow the heat to pass equally through the bar; then force in a strong blast, and as soon as it is observed that the iron is wasting, which will be detected by sparks passing off in the blast, dust a little white sand over the heat, which will melt and form with the oxide of iron a

fusible silicate of iron over the surface, but avoid turning the scarf towards the blast, which, if allowed to play direct on to it, will oxidise its surface and prevent a sound weld being taken.

Figs.



The practice of dipping heats into water unnecessarily must be avoided, as it tends to make them hard and more difficult to work under the chisel or file.

Overheating.—Avoid burning or overheating the iron, as it destroys its fibrous quality, its strength and tenacity.

Bending Bar Iron.

Whenever iron is bent at a sharp angle, it should, if practicable, be stouter at that point than any other.

A bar of square or flat iron up to about $\frac{3}{4}$ inch may be bent by first upsetting it at the part to be bent, and then bending it on the anvil at a white heat. (*See* Fig. 49.)

In bending a large bar of iron it is more convenient to cut it about three-quarters through at the back (Fig. 50), bend it at a white heat, and then weld in it a calking piece (*a*) at the corner, of the same size in section as the bar. This is better than upsetting.

Round iron is rarely bent at right angles. It is used for axles, spindles, shafts, bolts, &c.

Angle iron is bent at right angles across one of the sides by cutting a V-shaped piece out of the side (Fig. 51), of such a size as will allow the edges to overlap for welding when it is bent round to the proper position and welded. To assist in bending and prevent straining the iron, allow the chisel when cutting the (V) to cut quite up to the vertical web.

Tee iron, Fig. 52. Use a tool for bending this (*see* Fig. 53), with a groove across the angular top for the reception of the vertical (*b*). For bars up to about 2 in. in section, if bent at a white heat, it will not be necessary to cut a (V) piece out of the vertical.

Welding.

Welding is effected by first upsetting and scarfing the two ends. (*See* (*a*) Fig. 54.) The small ends, *b* b^1, should never be less than one-fourth the thickness of the iron or steel used. For a thick bar five men are required if obtainable, one to each bar to lift it about, and two with a sledge hammer each to strike ; but the entire lead should be given to the man who is "inside," *i.e.*, between the fire and the anvil. He will use a hand hammer to direct the position of the blows and turn the bars under operation. The strikers should be outside, and take the lead in striking from the position in which they stand, namely, the one on the left of the man inside should commence ; it is important to keep time in striking, as serious accidents may occur from striking one another's hammers.

To save time each man should know exactly what is to be done when a "*heat*" is brought out of the fire.

As soon as a good welding heat has been attained, each man will take out his bar at the same time, bring it to the anvil, brush off all the slag and dirt, and place the bars together in the welding position. The man outside will lay his bar on the anvil first, and the one inside place his on the top, but the point of the scarf (*b*) of the under bar should be clear of the anvil, as shown in Fig. 54, to prevent it from being chilled by the anvil. The strikers should direct their blows rather light at first, and then towards the point of the scarf at point *c* and in direction of dotted line ; as soon as this is soundly welded, the bar is turned over, and the other point of the

scarf is similarly welded. The bars will then have a good hold, the part which was upset is drawn out to the proper thickness, rounded or squared as the case may be, and cleaned off.

If this operation be well performed, no seam will be left along the edge of the scarf. Seams are sometimes of no detriment whatever; bars may be soundly welded and a seam left, and on the other hand they may be badly welded and no seam be visible. A seam may easily be taken out by taking a second heat.

Fig. 55.

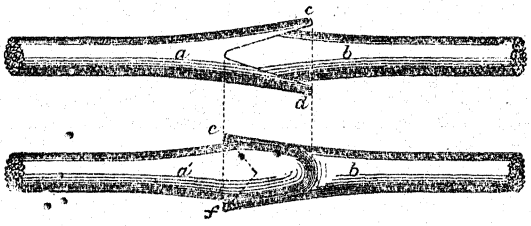
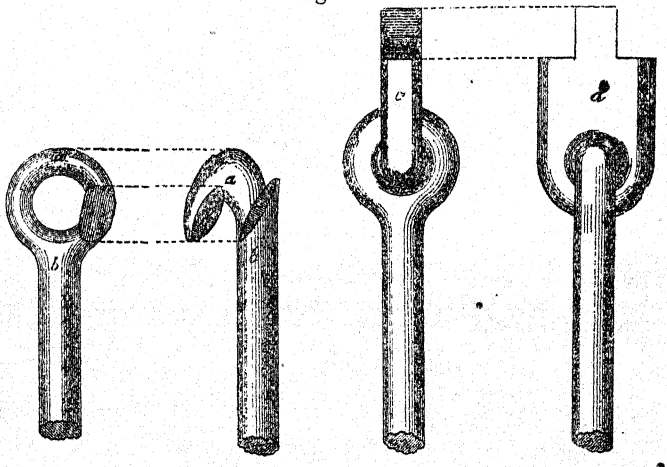


Fig. 56.

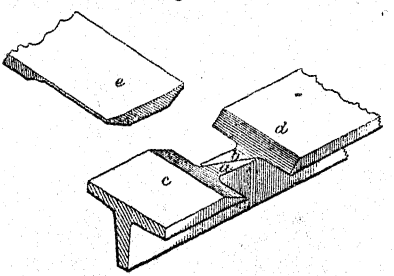


The plug and socket, as shown in Fig. 55, may be adopted for welding round iron, or mild steel bars. Cut the root of socket as shown by dotted lines in a^1 Fig. 55. If b is driven when hot into the socket, the points e and f will spread like c and d; these when closed will hold the bars firmly whilst the "welding heat" is taken. Thick bars should be welded while in the fire by driving the plug well into the socket, which will leave the points c, d, e, and f only to be dealt with on the anvil. The points should be left large as they will then act as "suckers," viz., draw the heat.

Fig. 56 shows how "double eyes" may be made. They should be forged out of the solid, then one of them cut with a sharp thin chisel, as shown in *a*, *b*, and the upper part turned back sufficiently to allow the other eye to pass in, as shown in *c* and *d*; it should then be raised to a white heat, the eye, *c*, *d*, passed in, and *a*, *b*, brought back to its place for welding. The welding heat should now be taken, and the weld made. If there are a number to be done, a top and bottom tool, made the required shape, will enable the work to be done easily.

Tee iron.—Tee iron may be welded by first cutting away sufficient of *c* and *d*, as shown (Fig. 57), to allow *a* and *b* to be upset and scarfed. When these latter should be welded, the piece *e*, which has been previously prepared (somewhat thicker than *c* and *d*), will be heated during this operation. The pieces *a*, *b*, *c*, *d*, and *e* should now be raised to a "welding heat" and *e* soundly welded on to *a*, *b*, *c*, *d*, and finished off. If a suitable bottom tool is available it should be used.

Fig. 57.



Angle iron.—Angle iron is welded by upsetting and scarfing in the usual way. It may be done on the edge of the anvil, but a tool with an angular top will be found more convenient. Two men should be employed for this operation, in order to weld both sides of the angle at the same time.

Bolts.

Bolts are made from mild round steel or iron of the required thickness. (*See* page 47.)

Principles of Bolts.—They are named after their diameter, length, and shape of the head, as $\frac{1}{2}'' \times 5''$ countersunk, boss head, square head, hexagon head, or cheese head.

Bolts are sometimes made square under the head, or with a feather to prevent their turning. Countersunk bolts are employed when the heads should be flush with the surface.

The diameter of the snap heads of bolts and rivets should bear a proportion to the diameter of the shank of 5 : 3; but hexagonal heads and nuts for bolts are made twice the diameter of bolt measured across the angles of the head.

The part to be screwed should be a little larger in diameter than the hole in the nut before it is screwed, in order that there may be a "full thread." The bolt should be a little less in diameter on the part to be screwed than on the plane part, in order that the thread may not be injured by driving the bolt into its place ; and also because in screwing a bolt (V threaded) the threads are a little larger in diameter than the same part before being screwed. The dies partly cut out and partly burr up.

Nuts.—The nut may be round, square, or hexagonal. When they are round they have two slots in their circumference for a fork wrench. The thickness of the nut should be the same as diameter of the bolt it is made for.

Making Bolts.

The smaller sizes of bolts are made by cutting the iron to the proper length, inserting it into the tool with the top end heated, and by using the stop tool the top end is readily upset and the head formed. For countersunk bolts the top is driven in flush with the tool. The part for screwing is drawn out between rounding tools.

Boss-headed bolts are upset by the use of the stop tool, and the head formed by a snap.

In the larger natures of bolts, if of iron, such as main pins for wagons, spindles and axles of garrison carriages, where they are not countersunk, the heads are formed by welding a collar on to the end of a piece of iron of the required size ; this is often easier and more convenient than upsetting.

The collar should be made from square or rectangular iron formed round the piece to which it is to be welded, and cut off so as to have the ends square, not scarfed, with a space of about $\frac{1}{4}$ in. between them for an inch bolt. The iron having been previously upset on the end to allow for wasting, should be placed while hot into the cold collar, and together raised to a "welding heat" ; then placed so that the collar is slightly over the anvil, the opening between the ends being downward. A few light blows given on the back of the collar will weld it at that point, and at the same time draw the iron so that the ends will come together, when the blows should be given towards and on the ends in succession, and the weld will be complete.

The trade rule to determine the length of iron required to make a collar (not to be welded on a spindle or bolt), or anything similar in form is :—*Three* times the diameter of hole and *four* times the thickness of iron to be used, one of the thicknesses being required for scarfing.

If the required bolts are steel and long, the end should be upset to form the head ; short steel bolts, however, can be readily made by drawing down from a piece large enough to form the head.

Rivets are made in a similar manner to bolts.

Nuts.

Small nuts are most conveniently made from flat iron or mild steel; a round hole is punched through the centre, which is adjusted by a mandrel, and the sides of the nut formed. The round part of

the taps (Whitworth's) with which it is to be tapped must accurately fit it. The back of the nut should be perfectly flat, the hole at right angles to it.

Screwing and Tapping.

Whitworth taps and dies are used for tapping and screwing for sizes from $\frac{3}{8}$ in. to 1 in. Before screwing any article, see that it is straight, cylindrical, and of the diameter stated, so that it will take a full thread and properly fit its nut.

To screw bolts.—Place them vertically in a vice with the point uppermost; place the required dies in their *proper* stock and close them up so that they will trace out the screw, and see that the stock is kept horizontal; run the stock down as far as required, close the dies a little and run it back again, and so on till a full thread is obtained.

To tap a hole.—See that the hole to be tapped is of the proper size, viz., the size of smooth part of the top of the tap (which is the diameter at the bottom of the thread) of which it is a gauge.

There should be a plentiful supply of oil, except when screwing copper, brass, or cast-iron.

There is a special arrangement for screwing and tapping for sizes below $\frac{1}{4}$ in., consisting of a screw plate with two rows of holes in it, one opposite the other, which act as dies. The holes opposite each other are pairs, one is a little larger than the other; the larger should be used first.

There are ten taps in the set, one for each pair of holes, and should only be turned with the wrench provided with the set, or hand vice.

Another screw plate, having six sizes, and two taps each size, the threads being British Association pitch, is approved. The plate, taps, and two small wrenches, are issued in a small wood box.

Collars.

Collars or washer are used under the nuts when they screw on to wood.

Bushes.

To make a bush, cut the iron the required length (*see* page 33),

Fig. 58.

scarf one end, and turn the iron as shown in Fig. 58, allowing it to

be somewhat oval at *a* and *b*. Take a clean welding heat, and after welding finish as required. A beck-iron or mandrel should be used according to size and length of bush.

Method of Working.

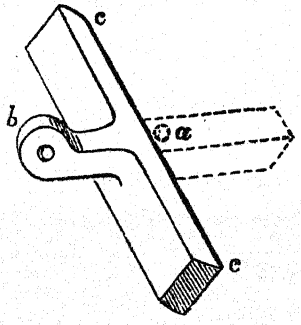
A few descriptions will now be given of the methods of making some of the common articles made by carriage and other smiths. In many cases he may have to make his own top and bottom tools mandrels, beck-iron, &c.

(*See* at end of book for the syllabus of instruction at Ordnance College workshops for the smiths of the several branches of the service.)

Drag Washer.

Drag or loop washers can be conveniently made thus: take a bar of iron of about $1\frac{1}{2}$ in. square in section, and about 6 in. long; heat it and draw the end out of the eye (*b*), then punch a small hole through it (*a*), as shown by Fig. 59; cut it open vertically to the long end, heat it and throw the two ends back (but not so much as shown in figure), draw them out to the proper dimensions, and scarf the ends for welding; draw out the short end (*b*) to form

Fig. 59.

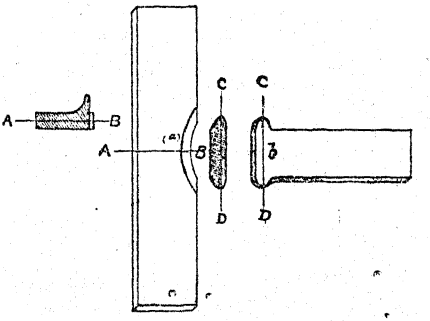


the loop, and punch the hole through it; then bend round the ends (*c*) on the point of the anvil, and when properly fitted weld them soundly. It should be welded a little small to allow for drawing out to the proper size, and made to the same cone on the inside as the axletree arm.

Splinterbar Socket.

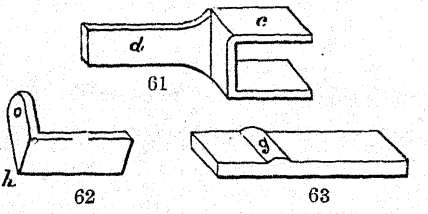
The socket is made by first taking a piece of flat iron $9\frac{1}{2}'' \times 1\frac{3}{4}'' \times \frac{1}{2}''$, and draw out a lip, as shown at (*a*), Fig. 60. Another piece of flat iron, $5'' \times 1\frac{3}{8}'' \times \frac{1}{2}''$, is drawn out and scarfed, as shown at (*b*), Fig. 60, and welded on to the lip at (*a*), Fig. 60.

Fig. 60.



The part (*a*), Fig. 60, forms the socket (*c*), Fig. 61, to fit on to the splinterbar, and the part (*b*), Fig. 60, forms part of the strap (*d*), shown in Fig. 61, for the reception of the shaft. An iron mandrel must be made of the exact size and shape of the splinterbar, so as to finish the socket (*c*) on after welding. The strap is increased in length by welding on a piece similar to that shown by Fig. 63,

Figs.

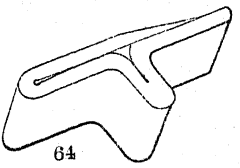


which, being bent at right angles at (*h*), Fig. 62, must be upset, and a calking must be formed at the point to be bent to increase the strength of the corner, as shown at (*g*), Fig. 63.

Socket for Swingletree.

Swingletree sockets for field services are made out of flat iron $12'' \times 2'' \times \frac{3}{8}''$; it is folded. (*See* Fig. 64.) Figs. 65 and 66 explain the rest. In the absence of a proper beck-iron, a temporary one should be made, and the socket welded on it, and finish on a mandrel.

Figs.



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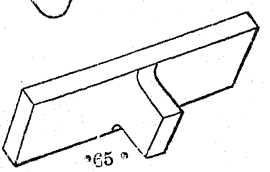
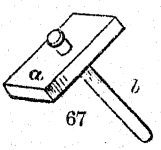


65



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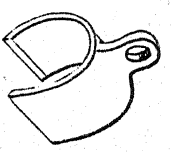


66

If many sockets are to be made, it will be best to make a top and bottom tool, each to receive half of the loop of the socket for its adjustment, which is performed by placing the loop between them and striking the top tool.

Hook for Swingletree.

Is made by taking a piece of flat iron about $6\frac{1}{2}'' \times 2'' \times \frac{1}{2}''$, a hole is punched through the centre for the reception of about 8 in. of $\frac{7}{8}$-in. round iron with the end upset, as shown by Fig. 67. The round iron is soundly welded into the plate. The plate (*a*) forms the socket, and the shank (*b*) the hook. The socket is welded on a beck-iron and finished on a mandrel.

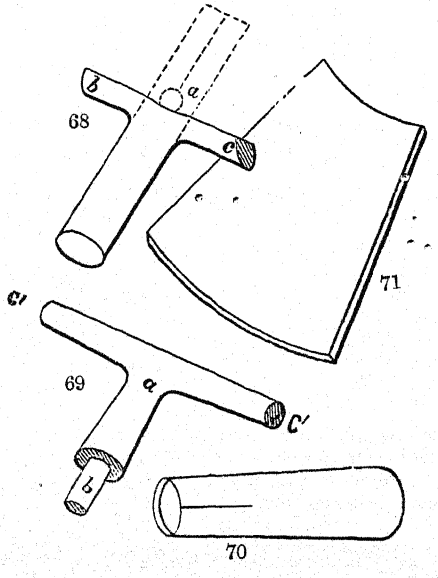
To make a No. 10, or steel, swingletree, take a piece of No. 16 W.G. double shear steel plate, $26'' \times 6''$, and bend it over a board $\frac{5}{8}$ in. thick (one edge of which having been previously rounded off), by gripping the plate and board in a vice, and using a mallet to turn the plate over the wood, taking care not to buckle the plate; when the bending is complete use a flatter on the sides over an anvil to make the surface flat. The edges should now be finished the required size.

The loops are to be of mild steel, and their bearing surfaces case hardened. When fitted in their position they will require to be carefully drilled, and then riveted. The rivets to be put in hot.

WADHOOKS.

Wadhook with Socket.—This is made from a piece of round iron by punching a round hole through the centre at a short distance

Figs.

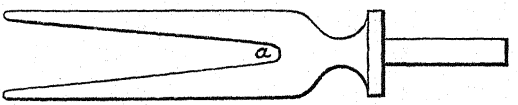


from the end; it is then cut open with a chisel from the hole to the end, and the arms (*b* and *c*) bent outwards from the hole at (*a*), Fig. 68. The arms are next drawn out, rounded and pointed, as shown at Fig. 68; the point is drawn out, and a shoulder formed as shown at (*b*), to fit the socket (Fig. 70). The socket is made out of plate iron (Fig. 71). The edges of the sides are scarfed a little, the socket is bent round on a conical mandrel, and welded on it for about three-fourths of its length from the large end. It is upset at the point, as shown, Fig. 70. The point of the shank (*b*), Fig. 69, is next inserted into the socket, they are welded together, and the neck formed in the shank at (*a*), Fig. 69, by drawing it out. The additional lengths required to form the worm are welded on at C^1, C^2, pointed, and bent round from right to left.

Wadhook without Socket.—Take a piece of $1\frac{1}{4}$-in. round iron, $3\frac{1}{2}$ in. long (1-in. round iron will suffice if upset to form the shoulder), fuller it, as shown in Fig. 72, draw out the small end to

Fig. 72.

Fig. 73.

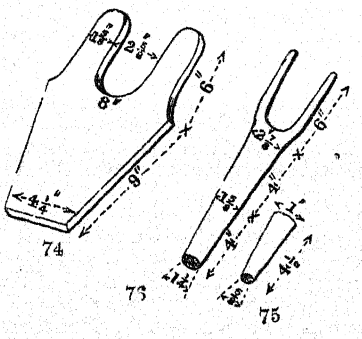


2″ × $\frac{7}{16}$″ to form the shank. The other end, Fig, 73, is drawn out, flattened, and a small round hole (a) punched through. The two prongs are drawn out at right angles to the shank, rounded, and tapered to a point, and turned in a spiral to form the worm.

Socket for Iron Pointed Lever.

Is made out of $\frac{7}{16}$ in. plate iron, first cut to the shape shown in Fig. 74 ; the sides are scarfed, and the plate bent on a conical

Figs.

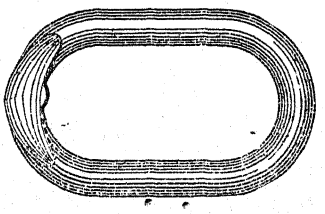


mandrel and welded, except about 3 in. at the point. A conical piece of iron, as shown in Fig. 75, is heated and placed in the socket from the top : it is of a size to fill the socket when their points are flush : a heat is taken, and the piece is soundly welded in, also the remainder of the socket welded ; this operation should make the point solid for about 4½ in. long. The point is drawn out and rounded to the proper diameter, Fig. 76.

Drag Chains.

In case of the fracture of a link in a drag chain, an ordinary carriage smith will have no difficulty in repairing it.

Fig. 77.



In putting in a new link, select the iron (from the material for the repair of carriages) of the same thickness as the link to be put in the chain. The scarf for welding should be long (*see* Fig. 77), clean, and well closed up before a welding heat is taken. The length of iron required will be twice the length, twice the width (both inside measurements), and twice the diameter of the iron. This is the rule for links of chain.

Annealing.—After chain has been in use a certain length of time it becomes brittle and is liable to break. All field carriages have their chains annealed to restore them to their original toughness; the date of this operation is stamped on the centre long link.

If the chains in a battery are found to break frequently, they may be annealed, if circumstances permit, in the following manner :—

Take a piece of wood (green, if procurable) about 4′ 6″ × 3″ × 3″ and drive it perpendicularly into the ground about 6 in. or 8 in., place 4 or 5 iron rods round the piece of wood so as to form a cone of 2 ft. in diameter at the base and 3 ft. high. Place the drag chains round this cone, keeping them clear of the ground about 6 in., and rising about 2 ft. high.

Six chains can be annealed at a time. Make a wood fire round the chains. Raise them to a blood heat, which can be obtained in about 15 minutes, when the fire should be entirely covered with ashes or grass turf, and all draught stopped, but this must be done so as not to chill the chain. The fire must be allowed to die out gradually. About 12 hours will suffice. Examine the chains carefully, and replace any links showing flaws.

In replacing the chains on the carriages, the hook must be heated and closed when on the loop.

The chains should receive not less than two coats of paint.

Chain in most common use is crane or roller chain. It is distinguished as short link, and by the thickness of the links, which vary from $\frac{1}{4}$ in. to $1\frac{1}{2}$ in. Common chain is distinguished by its weight per yard, which varies from $6\frac{1}{2}$ oz. to 14 lb.

Guard Irons.

To make the feet of guard irons for axletree boxes and G.S. wagons, take a piece of $1\frac{1}{4}$-in. round iron and fuller it, as shown in

Fig. 78.

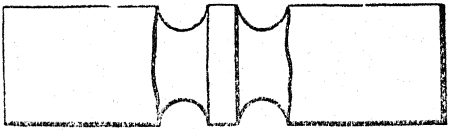


Fig. 79.

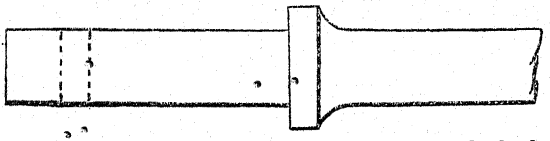
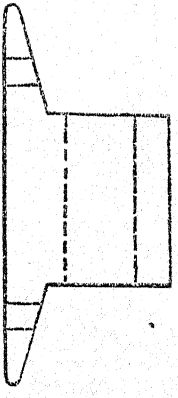


Fig. 78, draw out the ends, as shown in Fig. 79, punch the hole for flat key, and drift it. The feet are welded on to the remaining part of the guard iron.

Sockets, Guard Iron.

Sockets for guard irons for G.S., bread and meat, and bakery wagons are all of the same pattern. They are made from flat bar iron $2\frac{1}{2}'' \times 1\frac{1}{4}''$. The front edge is rounded, and a length of 4 in. is

Fig. 80.



cut off the bar to make one socket. A $\frac{3}{4}$-in. hole is drilled through the centre (*see* dotted lines in Fig. 80), and a $\frac{1}{4}$-in. hole is drilled through the centre at each end, 3 in. from centre to centre of each hole.

STAPLE, STAY, FOOT-BOARD.

This staple is used to connect the foot-board stay of G.S. wagons to the ear-bed. To make one, take a piece of iron ($4'' \times 1\frac{3}{4}'' \times 1\frac{3}{8}''$), fuller it across one edge in two places. (*See* Fig. 81.) Cut off the portions shown by dotted lines, and draw out the ends, Fig. 82.

Fig. 81.

Fig. 82.

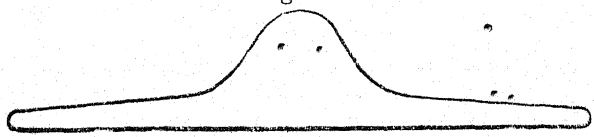


Fig. 83.

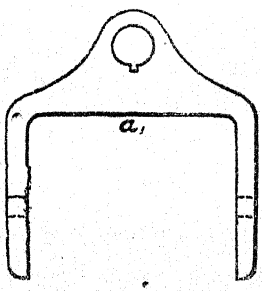
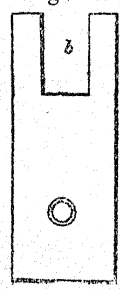


Fig. 84.

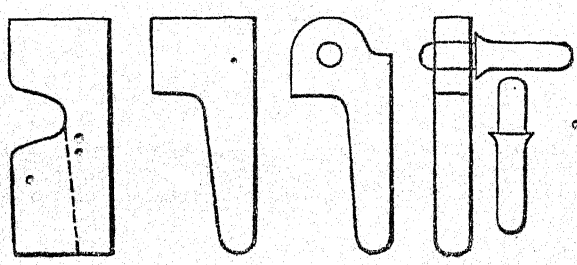


The ends are then bent, Fig. 83. The space for the stay is cut out, *b*, Fig. 84. The holes for the key and rivet follow.

Stay-plate.—The stay-plate for foot-board is made in a similar manner.

Figs.

85. 86. 87. 88.



Cranked Hooks.

The hooks in the rear ear-bed of ammunition, and store, and G.S. wagons are cranked downwards to allow the tail door to swing under the wagon without breaking the hinges.

For the shank of the hook use bar iron $1\frac{3}{4}'' \times \frac{3}{4}''$, and for the hook use $\frac{5}{8}$-in. round. Then rivet, weld, and finish to pattern.

Tail-door Joints.

These are made of mild steel the required size, and the hole drilled, but if an iron joint is wanted, it can be made as follows: take a piece of flat bar iron $1\frac{3}{4}'' \times \frac{5}{8}''$ long enough to conveniently handle, draw it, as shown by the dotted lines in Fig. 89 (side view),

Fig. 89.

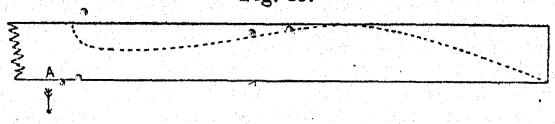
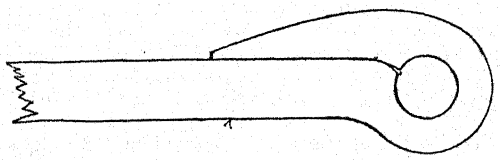


Fig. 90.



bend the end round a mandrel (Fig. 90), close the joint as much as possible, weld it up soundly and draw it out to the proper dimensions, and drift the hole out to $\frac{5}{8}$-in. diameter.

Putting Tires on Wheels.

1. Take the bar of steel or iron, lay it on the ground.

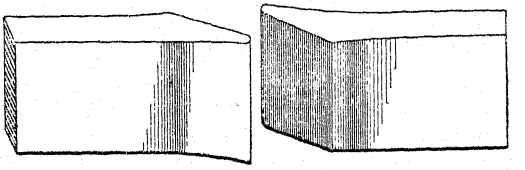
2. Take the wheel, and draw a line with a pencil on the side of a felloe down to the sole, place the wheel on the tire with the pencil line coinciding with the end (*a*, Fig. 91) of the bar, run the wheel over it one revolution, and mark this length across the tire (*b*), add 1 in. to *b*, and cut it there, viz., at *c*.

Fig. 91.

There is a certain amount of waste of material in welding the tire, and a certain gain due to shrinkage, closing up of felloes. Fair allowance of an inch provides for this. The opening of the felloes before tiring should not exceed $\frac{5}{8}$ in.

3. Upset scarf (the form of scarfing for iron, *see* Fig. 92, and for steel, Figs. 93, 94) and bend each end the required shape.

Fig. 92.



4. Lay the tire on the ground with the scarf of the bevelled end downwards. Bend it by placing a wheel upon it which is already shod, tying one end of the bar to the wheel very securely, and forcing the wheel round along the bar, keeping it well down; afterwards, on removing the wheel, complete the bending of the tire to the proper shape on the anvil.

5. Bend the ends so that they press against one another. Weld the tire a little short so that it can be drawn to the correct length. Clean the scarfings and thoroughly close them so as to exclude dirt in taking a welding heat.

6. Take a good welding heat, keep the tire about 6 in. or 8 in. from the nozzle, and let the fire play fairly across the sole, taking care that no part of it is burnt away. Tires up to 3 in. wide should be welded at one heat if possible; if it cannot be done at one heat, weld one side at a time. Finish it with a flatter, and neatly square the edges.

7. Test the length of the tire by measuring with the traveller, thus;—

Ascertain the circumference of the wheel by measuring along the centre of the sole, and mark this on the traveller.

Measure the circumference of the tire on the inside, and mark this on the traveller.

In this example the tire should be 1 in. shorter than the wheel. If the tire is too short, draw it; but if it is too long, it must be cut and re-welded.

8. Bevel the tire that it may fit closely down on the sole of the wheel by striking it on the inside along one edge on the anvil with the back of a sledge hammer. This should be done evenly all round; moderate blows about 3 in. apart will be found to give the correct level, approximately.

9. Heat the tire and put it on as follows:—Raise the tire 6 in. or 8 in. off the ground on stones, its larger diameter uppermost; make a wood fire round it, and bring it to a dull red heat, which may be obtained in about 20 minutes. Place a few (about six) stones or pieces of wood or iron, level on the top surface, at a convenient distance from the fire, for the tire to rest on. When sufficiently hot, draw the tire out of the fire carefully, so as not to bend it: pick it up with three or four pairs of tongs, and place it fairly on the stones. Place the wheel (face downwards) inside the tire. As soon

as the wheel is in its proper place, weight it at the nave to prevent it from being too much dished and to assist in closing up the joints in shrinking the tire; and pour water on it all round in order to shrink it, and also to prevent the wheel from being burnt. Make any adjustment necessary by striking the tire or felloe, but in striking the latter use a "flatter," and use a mallet or maul to strike the tire. Make any further adjustments necessary on the anvil with a flatter and sledge hammer.

The pipe box must always be taken out of a metal or iron nave while the tire is being put on, and the flanges bolted on with tire bolts.

10. Drill the tire for the bolts, one in the centre of each felloe, and countersink the holes to the proper size.

Steel Tires.

An important point to be ascertained is the best heat for welding tire steel. It will be found that it stands a greater heat and welds better than most kinds of steel.

Fig. 93.

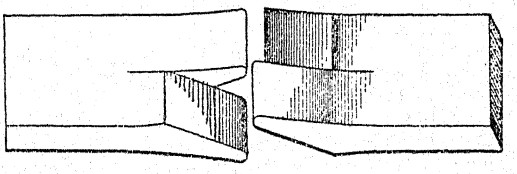
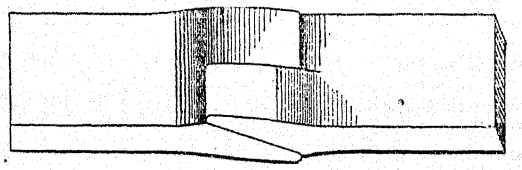


Fig. 94.



The length of the tire is obtained in the usual way, but instead of allowing the thickness of the tire for waste, allow 1½ in.

The ends are upset, scarfed, and a cut is made along the centre about 1¼ in. long, and these portions (*see* Fig. 93) are bent in opposite directions.

A few blows are then given on the opposite side of the tire on the inside, which bends the ends inwards and causes them to press hard against the other; they are thus securely held together during the operation of welding.

This system of employing an alternate lap for welding tire steel is much to be preferred to the ordinary method, as it would be necessary to employ an iron rivet to hold it together, and the iron

does not weld in with the steel. A steel rivet would be burnt before a welding heat was obtained with the tire, and a much sounder weld is obtained with the alternate lap.

Before a welding heat is taken, take a dull red heat and clean the scarf from all scales and dirt, and thoroughly close every opening of the scarf (*see* Fig. 94), so that no dirt or oxide can intervene to prevent a sound weld.

Take two heats to weld the tire (one side at a time); use a flux of borax and sand.

Re-tiring Wheels.

Ring Tires.—In the case of ring tires becoming loose on their wheels, and the feet of the spokes loose in the nave, caused by the shrinkage of the wood, they can be shortened so as to tighten up the spokes and felloes, and to be tight on the wheels, without cutting and re-welding, by heating the tire and dipping it horizontally in water up to the centre, and repeating the operation on the other side. This mode of shortening tires is particularly useful in the case of siege tires, which are very difficult to weld, but a qualified carriage smith should not resort to it for narrow tires, except when there is a scarcity of coal for use with the forge.

The operation is performed as follows:—

First remove all the tire bolts, stand the wheel on its sole, and drive the wheel out of the tire from front to back with a flatter (or a piece of wood) and sledge hammer.

Make a circular horizontal trench in the ground, about 6″ × 6″, and of a diameter to suit the tire. Place a few stones in the bottom of the trench to rest the tire on, and in order to ascertain their correct level pour a little water into the trench. Place the tire (before heating it) in the trench, and adjust it horizontally on the stones, and fill the trench with water up to the centre of the tire. Remove the tire from the trench, and mark the height of the water in it on a stick.

Heat the tire on the ground in the usual way, care being taken that it is heated to a red heat equally all round.

After filling the trench with water up to the proper height and the tire being properly heated, place it carefully in the trench without causing the water to rise higher than the centre of the tire. Not less than four men should be employed to lift the tire, and each with a pair of tongs. Care must be taken, in drawing the tire out of the fire and in lifting it, not to twist it. Should any of the water escape, it must be continually replenished, keeping it the proper depth until the tire is cool enough for a man to bear his hand on it.

Remove the tire from the trench, when it will be found that the part not immersed will have contracted.

The operation of heating and half immersing the tire in water is repeated, but this time the position of the tire is reversed.

Three or four tires could very well be heated at a time, but a corresponding number of trenches would be required.

A tire for a 5-ft. wheel will be shortened by this operation about

2 inches ; this may in some cases be found to be too short for the wheel, when a little may be cut off one or two of the opposite felloes (or at more joints, if necessary) with a hand saw to make the wheel fit the tire. This will be done much quicker than drawing the tire to make it fit the wheel, and shrunk wheels generally require the joints of the felloes cut to let them down on the spokes.

The length to be cut off the felloes, in order to make the wheel fit the tire, must be such that the tire will be shorter than the circumference of the wheel by twice the amount of the openings of the joints of the felloes on the centre of the face.

The pipe-box must be taken out of the metal nave wheels while the tire is being shrunk on.

Management of Steel.

The following are a few simple practical hints on the working of steel, which cannot be forged and worked so readily as iron. (*See* Qualities of Steel, issued to the service.)

Shear, and spring steel, are capable of being forged into various forms, and welded similarly to iron, but must not be raised to so great a heat ; the proper heat is when the steel just begins to "frizzle," which will be observed by sparks from the steel passing off in the blast. In this state the steel will be at a white heat, but not nearly so bright as that employed in welding iron. If it were raised to the same heat as iron, not only would the quality of the steel be impaired, but it could not be struck with hammers without dispersing it in all directions.

Tool steel is of the best quality of "cast" steel, and is suitable for tools of all natures ; it should be made "dead hard" without cracking, and ought not to split if worked into a tool and hardened at a "full red" in water.

Mild steel can be used for most purposes for which wrought iron has hitherto been used (excepting intricate forgings). It is capable of being bent double with a hammer when cold without showing signs of fracture.

Shear steel may be welded with a piece of iron, and afterwards hardened and tempered sufficiently to cut steel.

Spring steel is a specially manufactured variety. Its quality may be judged from the test applied before it is accepted for the service, which is as follows : a piece 2-ft. long is given a camber or bind of 3-in., then compressed to a straight line and allowed to remain for several minutes, after which it must not have acquired the least set.

Wire, hard steel, supplied for small tools, is of similar quality to tool steel, and should stand a similar test.

Wire, soft steel, is of the very best quality, and is tested by bending without fracture as follows :

Standard W.G., Nos. 1 to 17, round a piece of wire 1½ times its own diameter.

Standard W.G., Nos. 18 to 26, round a piece of wire of its own diameter.

The hard and soft wire are obtained in sizes ranging from S.W.G. 1 to 26.

Spring steel.—Spring steel is not suitable for edge tools.

Tool or Cast Steel.—Cast steel should never be raised to a higher temperature than bright red, as it will injure its quality, and if hardened at a higher temperature than dull red it is very liable to crack. This is due to the presence of a greater quantity of carbon than in any other steel, and while it can be forged into various forms, it cannot be welded except by using borax, which is reduced to powder, and the welding surfaces coated over with it when they are at a dull red heat; the parts are placed in a clear fire until the borax begins to burn, which will be observed by the smoke passing from it; at this stage the steel will be at a bright red heat, and the surfaces will be in a liquid state, and by quickly placing them together, a fairly good weld may be effected.

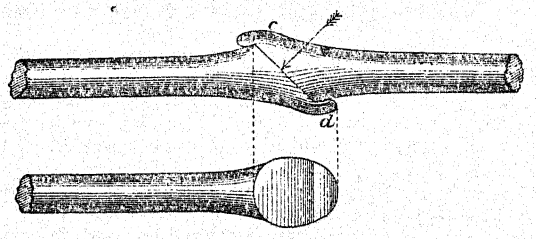
There are many articles made of cast steel, but it is especially adapted for making tools, such as taps, dies, cold chisels, and whenever a fine enduring edge is required.

Test of.—It may be tested for making tools such as taps (which have a deal of labour expended upon them before hardening), as follows:—

Cut a piece of steel off the bar proposed to be used, and try if it will harden at a low temperature; if not, the bar should be rejected, for if, when the taps were ready for hardening, a high temperature were necessary, the fine cutting edges of the threads would be destroyed in hardening. If the first test piece is satisfactory, try if a second piece cut from the other end of the bar is as good, then the bar may be used. This test is suitable for all steel required for instruments having a delicate cutting edge.

Few heats to be taken.—In all operations with steel, it is important to take as few heats as possible, because for every heating and hammering process which it undergoes, so much will its quality be injured.

Fig. 95.



Welding Steel.—A good weld may be effected by adopting the form of scarf shown at Fig. 95, which prevents the pieces from slipping when hammered. The blows must be delivered as shown by the arrow at first, then at point (*c*) and (*d*) in succession; if carefully heated and worked the weld should be a sound one.

The greater the heat the steel will stand, the more likely will it be to make a good weld; but all kinds of steel will not stand the same heat, and this point requires care and experience on the part of the workman to avoid over-heating and taking too many heats.

A flux should be used in welding steel. Calcined borax and silver sand make a good flux, common washing blue may also be used. Where many tools are ground on a grindstone, the sediment from the trough when dried makes a good flux for steel.

The object of using a flux is to remove all oxide, to present a pure metallic surface, and to fuse the surface at a temperature much below the ordinary melting point.

Hardening and Tempering Steel.

Steel, before being hardened, is almost as soft and malleable as wrought iron, but it may generally be hardened by heating and plunging it into water or oil; it should, however, never be immersed at a higher temperature than red, because the higher the temperature the more hard and brittle will it become after immersion. By heating it again to a little below redness, and allowing it to cool gradually, it will acquire elasticity, and when bent will spring back to its original position, whereas by putting iron through the same operations, it will undergo but little change.

Steel will frequently crack in hardening, particularly if immersed at too high a temperature, and steel articles of an irregular form, which are much thicker at one place than at another, are almost certain to crack if not skilfully managed. It is caused by the unequal contraction, on being chilled, of the different parts, due to their different thickness, and the whole of the steel not entering the water at the same instant. A piece of hot iron fixed to the thin part, or holes bored into the thick part, decrease this risk, or better still, by pouring a quantity of oil on the surface of the water. The effect of this is that on the steel being plunged into oil it instantly ignites, and adhering to the steel in a flaming condition, is carried down with it; the surrounding water is thus warmed, and coming into contact with the steel in that condition the contraction is uniform.

When steel has been heated and it is desired to cool it without hardening it, means should be adopted to cool it very gradually, such as covering it over with hot cinders or slacked lime; throwing it on the cold ground exposed to the air will harden it to a certain extent.

Hardening in oil.—Hardening steel in oil or tallow will have the effect of leaving it much tougher and less brittle than when hardened in water.

Hardened steel may be made soft again by heating and allowing it to cool gradually, and in this state it is capable of being permanently bent; but it may have only a certain amount of the hardness taken out by reheating it to a certain degree and immersing it, which fixes or clinches the temper of the steel, and in this manner

tools, &c., may have the requisite degree of hardness given to them to suit the purpose for which they are required.

Steel will acquire a certain colour, according to the temperature to which it is raised, and this is made use of as a guide in fixing the temper for different articles. The succession of colours which follow after heating a piece of steel are, *faint yellow*, *pale straw colour*, *full yellow*, *brown yellow*, *purple*, *bright blue*, *full blue*, and *dark blue*, which are due to a thin film of oxide of iron formed on the surface from being exposed to the air when heated; but in order to see the colours clearly, a portion of the steel should be bright for this purpose.

The proper colour for tempering the various articles herein mentioned must be determined by the nature of the metal, &c., to be worked.

Case Hardening.

Such articles as the locks of small arms, keys, &c., when they are required to possess the qualities of steel on the exterior, and also the toughness of wrought iron, are case hardened. The process consists of burying the articles in charcoal, or horn, bone, &c., and heating them to a bright red; under this operation the outer layer imbibes sufficient carbon to convert it into steel. A much more convenient system, and almost as good, consists in raising the articles to bright redness, and coating them over with powdered yellow prussiate of potash or scintilla grey, but in this case, as in others, it is carbon which enters the iron. The article to be hardened is raised to a red heat and covered on all sides with the powder. Put it in the fire again carefully, so as not to remove the powder, raise it to a red heat, and keep it so for about 1½ minutes. It is then removed and cooled; iron in water, and steel in hot water or oil. If hardening to a greater depth is required the operation may be repeated.

A clear hollow fire is necessary for this process.

Hardening Tools.

Cold chisels.—Tools for cutting iron, such as cold chisels, shears, &c., made of cast steel are hardened by immersion in water at a dull red heat, thus:—the tool to be hardened is plunged under the water for about a second; it is then held in a pair of tongs and watched until the heat remaining in the thick part passes down to the point, and the latter acquires the required colour, when the tool is again immersed and moved about under the water until cold.

If the point only be immersed at first, there is great chance of breaking it where it meets the surface of the water, which should be slightly warmed.

Re-steeling a Pickaxe.

The edge of the flat end is cut off, upset, a wedge-shaped piece of shear steel is placed on the back with the thick end coinciding with the edge of the axe; they are held together with a pair of tongs

heated and soundly welded. The edge is chamfered off on the inside, which leaves an edge of pure steel. It is hardened by immersion in water when at dull red heat; it is again heated to a light straw colour and immersed, which leaves in it a sufficient degree of hardness and removes the over brittleness left by the first operation. It is next ground. The edge when struck against granite stone should not become effaced.

The square point is steeled by first cutting a small piece off it, thus :—cut it open vertically for a length of about 3 in.; place a piece of cold flat shear steel in the hot point, heat them together and soundly weld them. The end is next squared up, the sides cut off, which removes all the iron and leaves a point of pure steel. It is hardened and tested similarly to the other end.

Limber Hook Key.

These articles are now made of steel, $1\frac{1}{4}$ in. diam., and to make them according to the ordinary method, by forging the feathers solid with the key, would prove a difficult operation with the field forge, besides special tools would have to be made for the operation. The best way is to first forge the key without the feathers, then make incisions for them; make the feathers, which may be of iron; drive them into the incisions cold when the key is hot; take a heat and weld them in soundly, and fit them with a file.

Steel Springs.

Making a Spring.—Steel springs are made from steel specially manufactured for the purpose, and of the required section. The plates are cut into lengths and drawn out at each end, about $1\frac{1}{2}$ in.; the ends are cut off with a "C" chisel; the slot in each end is punched in a tool to ensure its being cut clean without jagging the edges; the studs which are raised to enter the slots are raised with a punch with a rectangular point, but with the edges rounded off so as not to cut the steel when the steel is red hot. They serve to keep one plate fairly over the other. The top edges of the ends of the plate are chamfered off with a file. In some springs an eye is formed in each end of the bottom plate by rolling it round a mandrel. A hole is drilled through the centre of the plate for a bolt or rivet.

Hardening Springs.—The plate is next made red hot in a hollow fire, and roughly set to the required curve by placing it on a finished place, holding the plate in a vice, and pinching them together from end to end with tongs specially made for the purpose. The operation of hardening is completed by immersing it while still at a dull red heat in water.

Tempering Springs.—A plate is tempered by reheating it equally all over in a hollow fire, until it will cause wood to smoke and sparks to fly off when it is rubbed over it; it must be frequently

taken out of the fire to ascertain this, and to avoid the chance of overheating it and thereby destroying its elasticity. It is allowed to cool gradually, but during the cooling it is set, that is, it is made to coincide with another plate which is correct in shape. Any inaccuracy is corrected by striking the plate with a hammer on the anvil or vice.

The plates are ground on the surfaces which are outside when the spring is put together.

Testing Springs.—Springs are tested by weighting them at the centre until they are brought straight: they should stand this without breaking, and when the weight is removed they should go back to their original position without leaving any opening between the plates.

Re-bronzing or Re-blueing the Tangent Sight Deflection Leaves, and the Acorn Points and Sighting Blades of Foresights.

Re-bronzing Tangent Sight Deflection Leaves.—(1.) Polish the leaf well, and warm over a spirit lamp or gas flame (in order to dry off all moisture).

(2.) Polish with a brush, and blacklead to remove all grease.

(3.) Warm the leaf again until it is just too hot to hold in the hand, and apply bronzing mixture (which should be obtained from Woolwich) with a camel hair brush.

(4.) When thoroughly dry polish the leaf with a brush and black lead.

(5.) Remove any bronzing from the indicating arrow (or any other portion of the leaf which should be bright) by means of a fine file, and then varnish all over with shellac and spirit varnish (care being taken to warm the leaf before applying the varnish).

Re-blueing Tangent Sight Deflection Leaves, and Acorn Points and Sighting Blades of Foresights.—(1.) Clean off all the old blueing and polish the parts to be re-blued with fine emery cloth until quite bright.

(2.) Heat the parts over a spirit or gas flame, using a blow pipe if available, until the required colour is obtained.

The acorn point of the foresight should not be removed.

Solders and Soldering.

Soldering is the art of uniting together the surfaces of metals by the fusion or melting of a metallic composition run between the surfaces, and termed a solder. Soldering is divided into two branches, according to the temperature at which the solder melts.

Soft solders are applied with a "copper bit" or soldering iron, and melt below 300 C. Hard solders have a much higher melting

point, and fuse at a red heat. This branch of soldering is termed brazing, and requires the aid of a forge supplied with a strong air blast from a fan or other mechanical means. In all soldering, however, an alloy is formed between the solder and the surfaces of the article soldered, and whether hard or soft solders are used cannot be effectually carried out without the aid of a flux.

Soldering fluxes not only aid the flow of the melted metal, but clean the surfaces of the metal to be joined by dissolving the oxide which is always present upon the surface of a metal.

Hydrochloric or muriatic acid, generally known as "spirits of salts," is the most useful flux for soft solders. For soldering tinplate, brass, or copper articles, this acid must first be "killed." The killing is done by dissolving as much zinc as the acid will take up, or till gas is no longer given off, thus becoming chloride of zinc. This flux should not be used where rust would be injurious, but the danger is much minimised if after soldering the joint is wiped with a clean damp rag, and further with whiting.

Where spirits of salts cannot be obtained resin or resin and oil mixed is a good flux, and has the great advantage over killed spirits that there is no risk of rust afterwards. The edges of the article soldered, however, must be clean and bright, as resin has not the cleaning effect that spirits of salts has.

To soft solder easily and effectively the point of the copper bit must be carefully tinned. The point of the copper bit—by this is meant about an inch down each side from the point—having been filed smooth and bright is rubbed while hot, along with some solder, in a hollow made in a piece of sal-ammoniac, the point will then be coated with solder or tinned. When sal-ammoniac is not to be had, the soldering iron, after being made bright as before, should be dipped while hot into killed spirits, and the point rubbed with a piece of solder. This will answer the same as the first method.

A pot containing a weak solution of killed spirits or of sal-ammoniac water should always be at hand to dip the copper bit into in order to clean it previous to being applied to the work in hand. Care should be taken in not making the copper bit too hot as this destroys the tinning, rendering it useless, and necessitating filing bright again.

Soft solders for general use :—

	Lead.	Tin.
For lead	2	1
„ tinplate	1	1½
„ ordinary use	1	1

In hard soldering or brazing much skill and care is required, as the temperature to melt the solder or "spelter" being very high, there is a danger of the article being fuzed if not carefully watched.

Hard solders or spelter solders are generally composed of zinc and copper, although a little silver is sometimes added for special purposes.

The following are proportions for general use :—

	Zinc.	Copper.
For ironwork	1	2
„ copper and iron	1	1½
„ brasswork	1	1

Borax is the flux used, this substance melting at a high temperature, without evaporation, and dissolving the oxide on the surface of the metal, leaving it bright and clean. It must, however, be powdered fine in a mortar before being used. The strength of a brazed joint is greatest when the melting point of the spelter is as near that of the article brazed as can be used with safety.

To braze a straight seam a little moistened borax is rubbed on the outside of the joint to help the spelter through when melted, and the seam itself charged inside with the mixture of spelter and borax made into a paste with water, laying as much as will, when melted, fill up the joint. A clean coke fire being at hand, gently heat the seam until the borax is all down, then with a steady blast run the spelter down and the seam should be properly brazed. To ensure success it is generally advisable to well clean the edges forming the seam so as to ensure perfect union between the spelter and the metal being brazed.

Application of Plastic Metal.

1. Various parts of field artillery carriages, the rams of G.S. hydraulic jacks, and the pistons of some hydraulic buffers are coated with a layer of plastic metal (not less than ·015 in. in thickness) in the course of manufacture. This is done to prevent seizure and rust, and to reduce the friction between the surfaces. It is composed—

Tin ...	75 per cent.	Antimony...	12 per cent.
Copper ...	10 „	Lead ...	3 „

2. Axletree arms, axles of rollers and trunks, pins, spindles, and shafts of all kinds which have become worn at their bearings, can be repaired with this metal, and restored to their original dimensions. In no case is the plastic metal to be applied to more than one of two working surfaces. All surfaces thus prepared must be kept clean and well lubricated. When the rams of G.S. jacks become scored, they should be turned down in a lathe to make room for the metal, which is applied thickly all over ; when quite cool the ram is turned down to the proper dimensions.

3. Surfaces to be coated with plastic metal must be thoroughly cleaned from all grease and impurities, the article should, when hot, be lightly rubbed over with a smooth file to obtain a pure metallic surface. The temperature being just sufficient to melt powdered sal-ammoniac, the sal-ammoniac is well rubbed over the surface with an old smooth file made hot. The surface is then rubbed over with a strip of the metal, and the metal and flux well worked in with the file, sal-ammoniac and metal being added as

required until the surface is well coated or "tinned." Any remaining sal-ammoniac must be brushed off to avoid blow holes. In this way a thorough adhesion is effected between the two metals.* A coating as thick as is desirable can now be put on; the molten metal being applied by means of a ladle and worked into shape with two bits of hard wood (ash) shaped like a spatula. The article is allowed to cool gradually, and when cooled filed down or turned in a lathe to its proper dimensions; a straight edge and a serviceable pipe box being used as gauges for axletree arms, and a straight edge and the sockets or bearings being used as gauges for spindles, pins, axles, &c.

4. It is very important not to overheat the metal or the article to be coated. It will be found best not to heat an article in a fire, but to maintain it at the required temperature, by applying to it pieces of hot iron, or if possible a strong jet of gas from a Bunsen burner.

The following stores are sufficient for one second-class axletree :—

Metal, plastic	lbs.	2
Sal-ammoniac, crushed	oz.	¼
Cloth, Emery, fine	sheet	1

The following files are sufficient to do all the articles in a battery :—

Files, 2nd cut	½ round, 8 in.	2
	flat, 12 in.	2

Copper.

May be forged into bolts and various other forms, but it cannot be welded, and should not be heated higher than dull red. It is softened by immersion in water when hot, and hardened by rolling or hammering.

Sheet copper is known by its wire gauge (1 to 26), and by its weight per square foot.

Forges, Field, Bellows.

The forge bellows used for field service is most likely to get out of repair from the leather becoming dry and perished from the heat which passes into the bellows occasionally from the fire; dubbing must therefore be regularly applied.

Forge, Field, G.S., Mark II (Fig. 96).

This forge can be carried by either Marks II or III forge wagons but cannot be used on the tail door of the wagons (like Mark IV forge). It must be removed from the wagon, the frame erected on its legs, the blast pipe, cylinder, &c., secured in position.

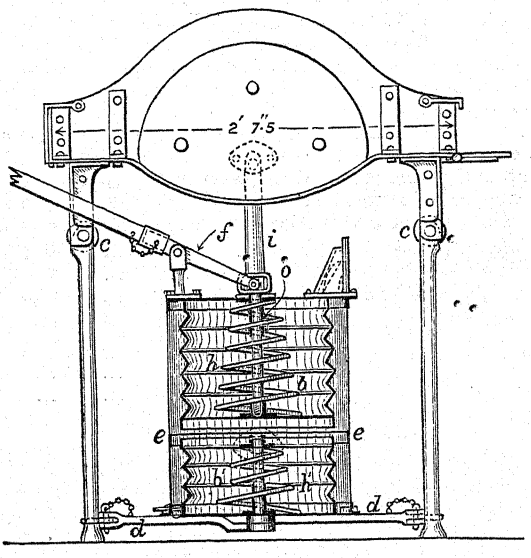
The following is a brief description of the cylinder and its component parts, viz :—

The bellows are enclosed in a sheet-steel cylinder. A sheet-iron

* When the article is ready to receive the thick coating, the heat applied to the former should be reduced, or the coating will probably slip off when cold.

partition (*e*) is blazed across the cylinder, dividing it into two separate chambers. The covers are made of iron-plate, 10 W.G.

Fig. 96.



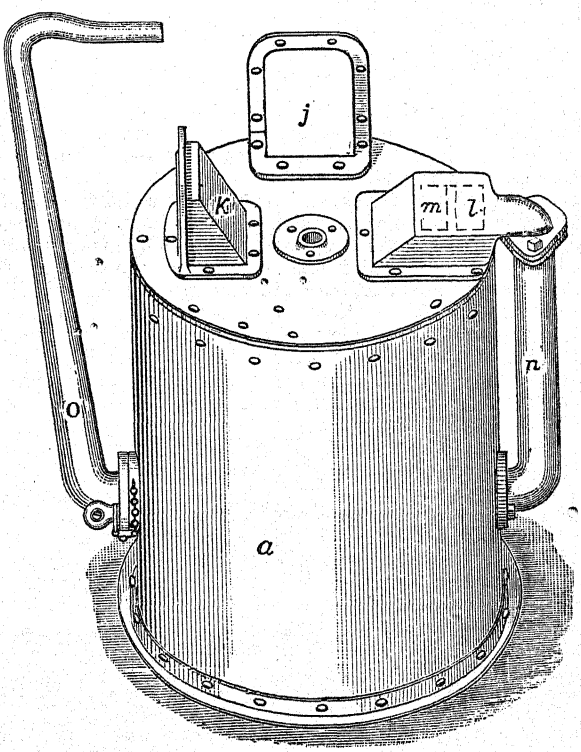
In the lower chamber there is a circular spring bellows (*b′*) secured to the inside of the cover, and kept in a perpendicular position by a round iron guide spindle, which passes through the cover. The inside of bellows is open to the atmosphere through holes in the cover. They supply no air to the blast pipe, but are necessary in the lower chamber (from whence all air passes to the blast pipe) to act as an elastic pad in equalising the pressure and maintaining a continuous blast, as they become compressed by the air pumped into the lower chamber from the upper.

There is a circular spring bellows in the top chamber (*b*) similar to that in the lower chamber and also secured to the cover. In each compartment the bellows are about 2 in. less in diameter than the cylinder to form air chambers. They are opened and closed by a $\frac{5}{8}$-in. iron rod (*o*), which passes through the cover and screws into the bottom of the bellows and is connected with a lever at the top (*f*). A spiral spring (*h*) works on the spindle.

Situated in the top cover (Fig. 97), are four valves—two inlet (*k* and *j*), (*j*) for the space round the bellows and (*a*) for the bellows. There are two outlet valves (*m* and *l*), (*l*) for the space round the bellows and (*m*) for the bellows.

The copper pipe (*n*) conveys the air from the upper to the lower chamber.

Fig. 97.



The steel pipe (*o*) conveys the blast from the lower chamber through the nozzle.

Action of the forge.—The down stroke of the lever closes the (upper) bellows, opens the inlet valve (*j*) which fills up the space round the bellows with air and opens the outlet valve (*m*), and the air in the bellows is discharged through the pipe (*n*) into the lower chamber. The up-stroke of the lever opens out the bellows, closes the valves (*j* and *m*) and opens the valves (*k* and *l*). The valve (*k*) fills the bellows with air as they are opened out. The outlet valve (*s*) is opened by the pressure put on the air outside the bellows by the latter being opened out and reducing the space round them, and the air is discharged through the pipe (*n*) to the lower chamber.

Care of the forge.—Should any of the valves not work properly, it may arise from dirt or the leather covering being damaged; these can be repaired by collarmakers. The bellows leather should have dubbing well worked into it, especially in hot climates. The spindle should occasionally be oiled.

The gauze coverings of (*k*) and (*j*) must be kept clean for free admission of air to top bellows.

Riveting.

Riveting may be either hot or cold, but the former should always be resorted to when practicable, because a sounder and stronger head can be formed, but when a rivet is passed through wood it must necessarily be cold.

In riveting plates of iron, such as the plates and frames of iron carriages, &c., the holes should be slightly countersunk on both sides, which increases the strength of the rivet by making it a little rounded under the head instead of cutting it in square. Before heating the rivets see that they will pass through the holes.

In hot riveting, the length of shank required to form a boss head should be equal to the diameter of the snap used to form the head; raise the rivet to a white heat, and after inserting it place a rivet holder or snap dolly at the back, or if it is a flat countersunk head, hold a sledge hammer against it, and partially form the boss head quickly with hammers, taking care to keep the rivet head fairly over the shank, and not make it too flat, use a snap to finish the head, carefully setting the head down all round without indenting the plate under it, but this must be quickly done while the iron is hot.

Cold riveting.—Much care is required in cold riveting. The rivet must be a good fit in the hole and the correct length, so that the projecting portion to be riveted is only sufficient for the required burr. A small hammer should be used for light rivets; at times, however, a smooth ended punch can be used with advantage; in this manner the surrounding metal is protected, the riveting being done by the point of the punch, upon the head of which the blow of the hammer is delivered.

Horse Shoes.

There are eight different sizes of horse-shoes in the Service, numbered respectively from 1 to 8; Nos. 1, 2, 3, and 4 are used for Cavalry and small horses; and Nos. 5, 6, 7, and 8 for Artillery, Engineers, and A.S. Corps.

A set of shoes includes four, two fore and two hind.

The present patterns of both fore and hind shoes, published in List of Changes, 1st June, 1910, and 1st May, 1911, respectively, are known as "plain stamped" shoes, and are without fullering or concavity.

All fore shoes, No. 1 hind shoes, and all hind shoes for wheel horses have one clip only, which is formed at the centre of the toe. Hind shoes for riding or lead horses (except No. 1 size) have a clip at each side of the toe, which is placed between the first and second nail holes on each side.

Wheelers' hind shoes (No. 7 size and upwards) have a calkin on each branch.

All the shoes are suitable for either "near" or "off," and they are provided with an increased number of nail holes, to allow of some freedom of choice in selecting the best situation for the nails, but no increase in number of nails used is required.

To make a shoe.—Hand-made shoes are "turned" either from new bar iron or from worn-out shoes. The latter method is generally adopted in the Service. It requires from one and half to two worn shoes to make a new one. The smith takes a worn shoe, bends it double at the toe, and between its doubled branches wedges half or more of another shoe, so that the result is several thicknesses of metal. These are welded together, and one end of the piece is drawn to the required size and shape of the half shoe. The nail holes are then stamped, beginning at the toe-hole. Their position is first lightly marked, and then with heavier blows the stamp is driven nearly through the web. The heel is then cut off at the proper length and to the correct slope with the half-round cutter supplied for that purpose, and the nail holes finished by pritchelling. The process is repeated on the other half, and lastly the clips are formed by holding the edge of the web over the edge of the anvil and driving through a sufficient amount of metal at the desired spot. The projection thus formed on the foot surface of the shoe is then drawn up over the tail of the anvil to the proper shape and thickness. The clip should be strong at the base, and a sharp angle at the inside should be avoided.

*Cold shoeing.**—Directions for the alteration of machine-made horse-shoes in a cold state.

Excessive violence is ruinous to the shoe.

Alterations should be made by moderate blows, commencing lightly and gradually increasing in force, using the beak of the anvil, except for the purpose of obtaining a level bearing.

Particular care should be taken not to use too much force in cold weather.

If suddenly struck hard the shoes will break, but if the blows are given gradually they will stand opening or closing to any reasonable length.

Before striking any blows on the shoe, care should be taken that it is bearing evenly on the anvil.

Shoes are very liable to break if altered on the ground; this practice should therefore be avoided.

VICE, BENCH, PARALLEL, 40 LB. (FIG. 99).

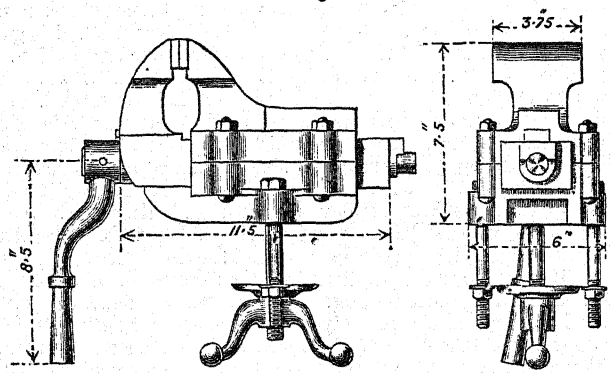
Instantaneous grip: with three holding-down bolts and one winged nut.

The gripping arrangement consists of two steel racks, one, having the teeth downwards, fixed in the lower part of the standing jaw,

* As per W.O. Circular Memo. 54/Artillery/5058, dated 5th January, 1897.

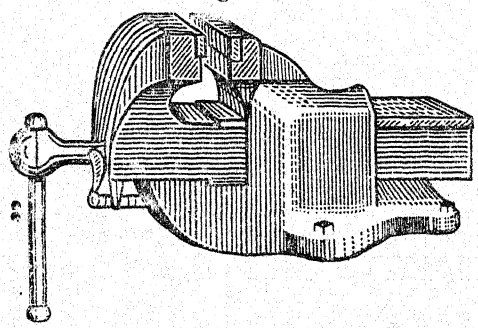
the other, a short movable one, having the teeth upwards, which, by means of a scrolled cam on the shaft to which the handle is attached, is placed in or out of gear, with the fixed rack. When

Fig. 99.
Scale $\frac{1}{3}$th.



the handle is vertical the racks are out of gear, so that the loose jaw may be moved freely ; a half turn of the handle then throws the racks into gear and causes the grip. The vice illustrated in Fig. 99 is now obsolescent, and will be replaced eventually by the Vice, bench, parallel, 45 lbs., with spring instantaneous grip, illustrated in Fig. 99a. The new vice differs from the previous pattern in having a fixed instead of a swivel base, and the power of the grip is increased by the action of a continuous screw in place of a cam. The screw is of the "buttress" type, and engages with a detachable half-nut, which is thrown in or out of gear by a rocking bar actuated by a lever fixed in a convenient position near the knob of the screw, and the form of thread used allows of automatic compensation for wear between the screw and the nut.

Fig. 99a.



SECTION III.

INSTRUCTION IN PAINTING.

General Directions.

Before painting any article it should be carefully examined in every part; all damaged portions repaired, splintered surfaces cleared off, nuts of bolts and screws tightened to ensure that the joints are drawn firmly together, and all traces of dirt or dust removed.

In all cases where the surface to be painted is coated with tar, it should be scraped and "coated over" with patent knotting, to cause the paint to adhere. Greasy surfaces should be scraped and washed with turpentine for a similar reason.

All blistered and perished paint must be scraped off* or burnt, and the parts cleaned before priming. When the old paint is hard, sound, and the surface smooth, all that is necessary is to rub it well with pumice stone.

No unsound material should be painted without its condition being first reported.

As a rule, drain holes are made to carry off any rain that may collect; these holes must be cleared thoroughly.

All paint brushes, when new, require to be "bound up" part way with string, to obtain good work from them; as they become worn they should be unbound by degrees until the string can be dispensed with. To bind a brush, take a piece of twine about 20 ft. in length, make a loop and pass it over the brush, allowing the loose end of about 10 inches on the left side. Now make a small loop at the short end and commence binding, keeping the short length underneath while so doing. The simplest way to do this is to turn the brush, keeping the handle towards the body, and guide the string, taking care it does not overlap. When bound up about 1½ inches finish off by making a half hitch from the point of the short end, and continue the operation until the opposite side of the brush is reached, the last half hitch being put on the opposite way. Lastly, pass the short end through the loop at the bottom and draw the loop out, then secure both ends of the twine by making two cuts in the handle close up to the stock of the brush, and force the twine into the cut with a knife. Brushes that have been in paint should be kept in water when not in use. If, however, they are to be kept in store all paint should be rubbed out of them, and they should be washed with turpentine. String-bound brushes are liable to burst

* Triangular scrapers and old swords should be used when possible; others may be made out of old files, if none other are at hand. Care should be taken that the edges, when ground, are uniform, so that they will not scratch the surface.

if placed too far in water after using. When not in use, only the hair should be covered by water, or the wood handle will swell, causing the twine to give way, which will render the brush useless. New brushes should be "broken in" on new work for priming and second coating before being used for finishing. Varnish brushes when not in use should be well washed in turpentine or kept in raw linseed oil.

Painters' Brushes.—The nature and sizes of paint brushes are denoted as follows :—

Ground or unground, 0 and 000. These are the large brushes used to apply paint to large surfaces, 0 being the smallest.

Ground brushes are those which have the square edges at the point ground off to a slightly conical form, which makes them suitable for laying on the finishing coat.

Sash tools are denoted as 2, 4, 6, and 8. They are small brushes used for laying paint on small surfaces : such as window sashes, small interstices, such as mouldings, &c.

Lettering Brushes.—It is very difficult to judge the quality of these brushes ; the only real test is trying them with colour when purchasing. Brushes with a bad point can be improved if first used upon rough surfaces, such as packing cases, which will tend to make them better adapted for finer and better work. These brushes are distinguished by the names of the quills which contain the hair. Thus there are "goose," "duck" (large and small—two sizes), and "crow" (large and small—two sizes). Sable hair brushes are the best. They should all be well washed in turpentine after using.

White Lead ground in oil should be covered with water or it will become hard.

Patent Driers, like white lead, must be covered with water after the tin has been opened.

Putty is supplied to all stations ; should the supply, however, become exhausted, it can be made with whiting mixed with raw linseed oil, but the whiting must be dry, or the putty will crumble away. It will become hard by exposure; this may be prevented by covering it with water or linseed oil.

Hard stopping, as used by coach painters, may be made with dry white lead mixed with gold size.

All paint, when thoroughly mixed, should be passed through a strainer before using.

Before painting new woodwork, all knots on soft woods should be coated with knotting applied quickly, and "laid off" with the grain of the wood.

In commencing to paint, it is best to start at the top and work downwards, from right side towards the left, spread the colour thoroughly across the work, and finally "lay off" with the grain of the wood. Before applying the second coat, all holes and crevices should be carefully stopped with putty. When the second coat is dry, the work should be rubbed down with glass paper, thoroughly dusted, and the finishing coat then laid on. If possible, each coat of paint should be allowed 24 hours to dry.

Painting should not be done in the open in wet weather, and after an article is painted it should be kept under cover, if possible, until it is thoroughly dry, as rain will readily spoil the work.

Carriages, Field, Travelling, Mountain and Siege.

In commencing the annual painting, &c., after removing all the ammunition and small stores, the first thing to be done is to remove all the strapping and fixed leathers and hand them over to the saddler, who will thoroughly clean, put them in good repair and apply hot dubbing with a brush. All boxes, axletree seats, and spare wheels should be removed, and the guns dismounted.

Rust will be found on the top surfaces beneath the ammunition boxes. This must be thoroughly removed, and all edges of broken paint rubbed down. A considerable number of bare places will also be found about the poles, shafts, splinter-bar, foot-boards, seatings on limbers and ammunition wagons for boxes, trails, corners of boxes, &c., which must receive a priming coat of paint.

Field carriages receive one coat of service-colour paint annually. All new material used in repairs should receive three coats of paint. The carriage or article to be painted must be thoroughly dry when painted, and before applying the paint must be well brushed over to clean it of all dust, scrapings, &c. In painting, the paint must be well worked down to the bottom of any cracks

Stopping.—After giving the coat of priming, the cracks are stopped, as the stopping would not otherwise adhere. If the cracks are large, slips of wood should be put in to fill them, and secured with brads before applying the stopping.

The stopping must be well worked in with a putty knife.

Very little stopping is required about iron field carriages.

As iron field carriages only receive one coat of paint, they must be primed only at those parts which have been rubbed bare, and where stopping is required.

Parts not to be painted.—Elevating and traversing screws, worm shafts, teeth of wheels, inside of friction cones, all frictional surfaces, trunnion bearings, inside capsquares, axletree arms, linch-pins, washers, and end of Brandling shaft irons. These parts, and all points of axletree arms, must be kept bright and slightly oiled.

All hinges, hasps, turnbuckles, &c., after being cleaned, should have a few drops of oil placed in their joints. This should be repeated from time to time while they are in use.

Paint is issued to the service in tins already prepared, and generally, previous to use, requires nothing more than stirring, although in damp, dull weather it is sometimes an advantage to add either a little turpentine or patent driers to expedite the drying; but preference should be given to driers. When paint is too thick for use add turpentine in small quantities to thin it.

List of Paints and Directions for Mixing.

Giving the proportions of the ingredients, and where principally used.

The proportions given are those for the finishing colour.

1. *Lead Colour.*

Ingredients.	Lbs. ozs.	Where used.
Ground white lead	4 0	For wood artillery carriages, field iron carriages, engineers', and transport carriages, &c., excepting S.A. Ammunition carts and wagons, which are painted service colour.
Lamp black ...	0 11½	
Patent drier ...	0 9	
Raw linseed oil for mixing	2 7	
Turpentine ...	0 2	

Place the white lead in paint cans, adding driers, oil and turpentine. Well mix until the lead is all broken up, then add the lamp black, finally passing through a paint strainer.

When a light colour is required, the quantity of lamp black is reduced.

2. *Stone Colour.*

Ingredients.	Lbs. ozs.
Ground white lead...	4 0
Stone ochre...	0 0½
Turkey umber	0 1
Patent driers	0 6¼
Raw linseed oil for mixing	1 6

The colour may be varied by the quantity of Turkey umber employed. A common stone colour can be made without adding ochre.

Place the white lead in paint can, adding driers and oil. Well mix, then add umber and ochre, and strain.

A small quantity of turpentine can be added to the priming and second coat.

3. *Service Colour.*

For small arm ammunition carts and wagons only.

Ingredients.	Lbs. ozs.	galls.	qts.	Remarks.
Lead, white, ground	38 0			
Ochre, store	26 8			To make 1 cwt.
Umber, Turkey, burnt ...	9 8			
Black, lamp, ground	0 12			
Driers, patent	9 8			
Blue, Prussian	0 12			
Oil, linseed, raw		2	1	
Turpentine		0	3½	

Directions for finishing coat.—Place the white lead, ground, in paint can, add driers, oil, linseed, and turpentine. Well mix, then add other ingredients and strain.

4. *Red Paint.*

Ingredients.	Lbs. ozs.
Venetian red, ground	4 0
Boiled linseed oil for mixing	0 14
Driers, patent	0 5
Turpentine	0 2

Place the red, Venetian, in paint can, add driers and oil ; well mix and strain.

5. *Black Paint.*

Ingredients.	Lbs. ozs.	Where used.
Lamp black, ground	4 0	For general use: also for carriages and slides, naval, wood.
Oil, linseed, boiled, for mixing ...	1 6	
Turpentine	0 5	
Driers, patent	1 0	A very dark lead colour is used for priming and second coat.

Place the black in paint can, add driers, oil and turpentine ; well mix and strain.

6. *Magnetic Oxide Paint (Black).*

Ingredients.	Lbs. ozs.	Where used.
Black, Pulford's, ground... ...	4 0	For painting articles made of iron, such as garrison carriages and slides, iron ordnance projectiles (pile iron out in the open), gyns, &c.
Boiled linseed oil	1 6	
Turpentine	0 2	
Litharge (driers)	0 4	

Place the black in paint can, add driers, oil and turpentine ; well mix and strain.

7. *Red Lead Paint.*

Ingredients.	Lbs. ozs.	Where used.
Red lead, dry	4 0	For wood or iron tanks, &c., to contain water, jointing of ironwork cover, hydraulic buffers, &c.
Litharge or patent driers ...	0 2	
Boiled linseed oil	1 6	
Turpentine	0 2	

Place the red lead in paint can, add driers, oil and turpentine ; well mix. This need not be strained, but when kept, needs to be constantly stirred up to prevent red lead sinking to the bottom.

8. *Black Lacquer.*

Ingredients.	Lbs. ozs.	Where used.
Black, lamp, dry	0 2	For bores of muzzle-loading rifle guns.
Lead, { black, dry	4 1	
Lead, { red, dry	1 2	
Oil, linseed, raw	2 7	

9. *Black Varnish.*

Ingredients.	Lbs. ozs.
Gum shellac	6 0
Methylated spirits...	14 0
Venetian red	2 0

Before this mixture is applied the old paint must be carefully scraped off.

10. *White Paint.*

Ingredients.	Lbs. ozs.
White lead, ground	4 0
Driers, patent	0 5
Oil, linseed, raw	1 6

Place the white lead in paint can, add driers and oil; well mix and strain.

N.B.—For priming and second coat add a little turpentine.

11. *Chocolate Paint.*

Ingredients.	Lbs. ozs.
Red, Venetian, ground	4 0
Black, lamp, ground	0 4
Driers, patent	0 5
Oil, linseed, boiled	1 0
Turpentine	0 1½

Place the red in paint can, add driers, oil, turpentine, and lamp black ; well mix and strain.

This colour will cover over a light lead colour ground, and the shade may be varied according to the amount of lamp black used.

12. *Green Paint.*

Ingredients.	Lbs. ozs.
Green, Brunswick, ground	4 0
Driers, patent	0 4
Oil, linseed, boiled	2 0
Turpentine...	0 5

Place green in paint can, add driers, oil and turpentine ; well mix and strain.

The shade can be varied by adding light Brunswick green ; the more of the latter the lighter the shade.

13. *Venetian Red (Spirit Colour).*

Ingredients.	Lbs.	Pints.	——
Shellac, orange	6	—	For painting the inside of cordite cases, &c.
Spirits, methylated	—	14	
Red, Venetian, dry	2	—	

14. *Stone Colour Paint.*

Ingredients.	Lbs. ozs.	Pints.	——
Lead, white, ground	1 2	—	For painting Maxim guns.
Umber, burnt	0 1½	—	
Ochre, spruce	0 6	—	For 8 guns (barrel casing only) one coat each.
Driers, patent	0 2⅔	—	
Varnish, gold size	—	⅓	
Oil, linseed, boiled	—	⅓	
Turpentine	—	⅓	

The colour of the paint may be varied to suit local conditions, such as background, &c. The quantity required must be 1 lb. for 8 shields (front service only).

15. *Waterproof Service Colour for Canvas Covers.*

Ingredients.	Lbs.	Galls.	Remarks.
Lead, white, ground	364	—	To make 1,262 lbs.
Ochre, stone, Oxford, ground	244	—	
Umber, Turkey, burnt ...	75	—	
Black, lamp, ground	11	—	
Blue, Prussian...	9	—	
Driers	150	—	
Oil, linseed, boiled	—	37½	
Soap, yellow	9	—	
Water	—	12½	

This composition is special and a paint.

16. *Waterproof Paint (Black).*

Ingredients.	Lbs.	——
Wax, black	10½	Apply with an ordinary paint brush.
Litharge, driers	10½	
Oil, linseed, boiled	16½	
Lamp black, ground in oil	7	

It must on no account be used on "Abel's Composition."

To Paint Galvanized Ironwork.

To effectually paint galvanized ironwork or zinc, it should be well washed with a solution of the following equal parts :—

Chloride of copper.	Sal-ammoniac.
Nitrate of copper.	Hydrochloric acid and 130 parts of water.

Instructions for Marking Vehicles.

Miscellaneous Marking.

Regimental Details.

Certain details are marked on vehicles, &c., for regimental convenience.

The general principles will apply in the case of any vehicle for which specific details are not given.

Medical Units.

All vehicles in possession of medical units will be marked with the Geneva cross.

Weight and Load.

The "weight of vehicle" and the "weight of load the vehicle is designed to carry," as shown in List of Changes, will be marked on the near side of the vehicles, as near the centre as possible, low down.

Station Transport, &c.

Vehicles on charge of units for local purposes will be marked to show the purpose to which they are locally appropriated.

GENERAL INSTRUCTIONS.

Diagrams are published to illustrate the method of marking vehicles; supplies will be obtained from G.O.C.'s of areas as required. These diagrams are only issued as guides, and where they differ from equipment regulations the latter must be followed, *i.e.*, Equipment Regulations, Part I, 1912, Appendix XX.

The marking of vehicles will be performed by hand-painting, by battery and regimental artificers. In the absence of artificers trained to hand-painting, vehicles will be marked by the A.O.D.

White paint will be used for all markings with the exception of the Geneva cross, which will be red on white ground. The size of letters and numerals will be as shown below.

Vehicles in possession of units either as peace or mobilization equipment, and those held by A.O.D. with mobilization equipments, will be marked in full. Any necessary alterations in the marking consequent upon the changes of units in course of relief, or when vehicles accompany a unit on change of station, will be at once carried out.

Size and Style of Marking.

Marking.	Size of letters and numerals.	Style.
A.S.C. train marking (including train number and contents of vehicle)—		
Capitals and numerals	2-inch	Plain block, except division numeral, which will be "Roman."
Remainder	1½ "	
Weight and load of vehicle	¾ "	
All other marks—		
Capitals and numerals	1½ "	
Remainder	1 "	

List of Diagrams showing Method of Marking Vehicles.

No. R.C.D. 11746A (2).	Vehicles.
Sheet 1	Wagons—Artillery ; ammunition and store, R.A.
„ 2	„ Air-line ; cable ; light spring, R.E. Cart, cable.
„ 3	„ Boat ; pontoon ; G.S., R.E.
„ 4	Carts—Forage ; Maltese.
„ 4A	„ „ „ (special to A.S.C. units).
„ 5	Wagons—Wireless telegraphy.
„ 6	Carts—Tool, R.E.
„ 7	Wagons—Limbered, G.S. Carts, S.A.A
„ 8	„ Ambulance.
„ 9	Carts—Water, tank.
„ 9A	„ „ „ (special to A.S.C. units).
„ 10	Kitchens, travelling.
„ 11	Wagons, oven, steam.
„ 12	„ G.S.
„ 12A	„ „ (special to A.S.C. units).
„ 13	Q.F. 18-pr.—Carriages, limbers and wagons.
„ 14	Q.F. 13-pr. „ „ „ „
„ 15	B.L. 60-pr. „ „ „ „
„ 16	B.L. 5-inch howitzer—Carriages, limbers and wagons.
„ 17	B.L. 6-inch, 30-cwt. howitzer—Carriages and limbers.
„ 18	B.L.C. 15-pr.—Carriages, limbers and wagons.
„ 19	Carriages—M.G., infantry, Maxim, ·303-inch.
„ 20	Q.F. 4·7-inch—Carriages and limbers.
„ 21	Q.F. 15-pr.—Carriages, limbers and wagons.
„ 23	Q.F. 4·5-inch howitzer—Carriages, limbers and wagons.
„ 24	B.L. 10-pr.—Carriage and packsaddle.
„ 25	Wagon—Telephone.
„ 26	B.L. 2·75-inch—Carriage and Packsaddle.

Transport Vehicles.

For instruction in cleaning and painting, *see* page 61.

In taking wagons and carts in hand for cleaning and painting, they should be taken to pieces as far as possible. The hoops, sides, and fore carriages of General Service wagons must be removed ; the hind wheels scotched, and the bottom thrown up so as to rest on the rear end ; after painting the bottom and fore carriage, replace the latter ; paint the sides, and stand them loosely in the clips ; and, after painting the head and tail, doors, partition board, seat, hoops, &c., stand them on one side until all the parts of the wagon are dry before putting them together. In the case of Bread and Meat, Bakery, and other wagons with covered tops, the tops are not to be taken off for painting.

Garrison Carriages, Slides, &c., Iron and Wood.

All carriages, slides, guns, &c., forming the armament of fortresses, and projectiles exposed to the weather, are cleaned and painted biennially ; but where exposed to the spray of the sea, they will be painted oftener if considered necessary by the Officer Commanding the Royal Artillery.

Whenever it is convenient to dismount the guns and place them on skidding before commencing to clean and paint it should be done ; but in cases where it is deemed undesirable to dismount the guns, they must be raised up out of their trunnion bearings to admit of the necessary cleaning and painting.

Scraping and Cleaning.—These carriages and slides require a great deal of scraping and cleaning, especially if mounted in open works. Before proceeding to paint them they must be stripped of all their loose parts, and all the old paint, rust, and corroded oil thoroughly removed.

Iron Carriages, Slides, &c.—Care should be taken that all nuts, screws, &c., are properly tightened up before commencing to paint ; also any broken or loose rivets should be replaced by new ones.

They are painted with Pulford's black magnetic oxide, which is issued to the Service ready for use, but must be well stirred before it is poured out of the tins ; also while in use.

Parts not to be painted.—The shafts, spindles, teeth of wheels, elevating arcs, axles, piston rod of hydraulic buffer bearings, and frictional surfaces are not painted, but before being replaced should be thoroughly cleaned, and, except the teeth of wheels, made bright and oiled. The top surface of the sides of the slide and the bearing surface of the carriage also are not painted ; these should be made clean but not bright, and very slightly coated with oil to prevent "seizure."

As in all other cases, the carriage and slides should be thoroughly dry when painted, and the paint should not be laid on too thick, but lightly applied, and carefully finished.

The stopping is done after giving the priming coat of paint. Before giving the finishing coat to either gun, carriage, or slide, except the inside of the carriage, mount the gun ; then give the finishing coat over all, care being taken that the first coat is thoroughly dry before the second is given. Any paint rubbed off the carriage and slide from time to time should be patched over at once to prevent their rusting.

A white line, 1 in. wide, is painted on the bottom edge on each side of the carriage, about 2 in. long, and extending over the top outside edge of the slide. The lines coincide on the carriage and slide when the carriage is run up to the front stops. It is used to indicate when the gun is "run up."

Wood Carriages, Slide, &c.—It is only necessary to mention specially for these, in addition to the foregoing, that any openings at joints, caused by shrinkage, &c., should be closed by tightening the bolts, and large shakes must be stopped with painted slips of wood.

They are painted with the ordinary lead colour.

Marking Garrison Carriages, &c.

Roman and Egyptian block letters and figures are in general use, but the natures and sizes of letters and figures will be settled locally.

Liquid Knotting.

Patent liquid knotting is used to paint over knots in wood, as paint will not adhere firmly without it. When patent knotting is not available, a good substitute may be made as follows:—Dissolve six ounces of orange shellac in one pint of methylated spirits. It is similar to varnish, and should be applied quickly with a brush, as it soon sets.

Mineral Jelly, Red.

Is used in field and garrison service for coating bright ironwork, &c.

Grease, Lubricating.

Is used as a lubricant, and is issued in two kinds :—
For "hot" or "cool" climates.

Polishing.

Staining before polishing.—Before applying French polish, the article to be polished should be well "got up," *i.e.*, perfectly smooth, clean and dry. Such woods as mahogany or walnut should be rubbed over with raw linseed oil. If the mahogany is of a light colour and "poor looking," a rich colour may be imparted to it by mixing a small quantity of dragon's blood with the oil, or if a small quantity of alkanet root be soaked in the oil for a short time ; the colour may be easily regulated according to taste. To facilitate polishing, small pores in the wood may be stopped with plaster of Paris, mixed with water (when dry clean off with glass paper) ; or as is sometimes done if the wood is soft and very porous, by giving it one coat of brown hard varnish with a flat camel hair brush before applying the polish.

In mouldings, &c., where polish cannot be applied with the rubber, a brown hard varnish may be applied steadily and evenly with a camel hair brush ; or what is still better, apply gum benzoin with a sponge, care being taken not to lay it on too thick, nor to go over the ground twice until the previous coat is dry.

Polishing should be done in a dry warm room where there is no dust.

Polished wood which may have become dirty is cleaned and revived by washing it with soap and water, using a sponge or flannel, and when perfectly dry, rubbing it over vigorously with equal parts of turpentine and vinegar. This must be rubbed off after with clean cotton rags and fresh polish applied if necessary.

The polish is applied as follows:—Saturate a piece of clean wadding with polish, and enclose it in a piece of fine linen ; hold the gathers tightly in the hand ; flatten the rubber somewhat, and apply a little raw linseed oil to its face with the finger, to prevent it sticking to the wood ; rub gently over the whole surface of the work, taking care not to rub too often in the same place. This

process should be continued until a sufficient body is obtained, the wadding being replenished with polish when the rubber becomes dry.

The work should stand for 24 hours, when it can be lightly rubbed down with fine glass paper. Then apply the rubber as before, but with a few drops of methylated spirits on its face instead of oil, until the required body is obtained. Finally, finish off with a new rubber, with a few drops of methylated spirits only applied to its face. The latter will remove the oil and give a bright surface on the work, but *too much methylated spirit will remove the polish.*

French Polish.

Spirits, methylated	1 quart.
Shellac, orange	½ lb.
Gum, sandarach	¼ oz.
Gum, mastic	½ oz

Dissolve in a warm place and strain off for use.

French Polish Reviver.

Dissolve a piece of camphor the size of an ordinary walnut in half a pint of methylated spirits. Add half a pint of oil, linseed, raw, and half a pint of vinegar. Mix well together by shaking. Apply with a piece of old fine linen, and finish off with a dry rubber.

Note.—If preferred, the camphor may be omitted.

Copal Varnish.

Oil, linseed, raw	3 gal.
Litharge, dry	¼ lb.
Turpentine	5½ gal.
Gum, pale, copal	8 lb.

Directions for Mixing.

Heat the oil to boiling point and add the litharge while boiling. At the same time heat the gum in a separate vessel until it is well fuzed. Then pour some of the oil into the gum pot and well stir together. Next pour in the remainder of the oil and stir the whole together until the varnish is of the proper consistency. This is determined by taking out a little and trying it between the thumb and finger, when the varnish should "string" or exten into threads. Remove the pot from the fire, and when cooled a little, add the turpentine and bottle off for use.

Note.—Varnish when once exposed to the atmosphere should not be returned to the bottle, but "used up." A little turps will expedite drying if terebene cannot be obtained.

Varnishing.

Sizing.—Articles to be varnished should be got up in a similar manner to those for polishing, but before applying the varnish the

wood should receive a coat of size to prevent the varnish from soaking into it. The size used with hard woods consists of equal parts of gold size and turpentine, and for soft woods of boiled linseed oil, though very frequently glued size, *i.e.*, glue boiled in water (particularly where the colour is of no consequence) is used, being applied hot with a brush.

Copal varnish is used more particularly for the woodwork of buildings, such as doors, partitions, rails, &c.

Brown hard varnish is suitable for furniture, as it stands friction well, dries quickly, sets very hard, and has a bright appearance.

When stopping is required, common putty stained with dry colours can be used thus :—

For mahogany, stain with Venetian red and darken with lamp black.

For teak colour, stain with burnt umber.

For yellow pine, stain with Oxford ochre.

Terebene, a liquid drier, can be used for hastening a slow-drying varnish.

Crystal or Transparent Varnish is used for diagrams, maps, and wall papers, but two coats of *best patent size* should be given before the varnish is applied to the work.

To remove old varnish, coat it with washing blue, let it dry on ; afterwards wash thoroughly and allow surface to dry.

Staining.

Articles, such as desks, cupboards, tables, &c., made of common deal, may have their appearance sometimes very much improved by first giving them a coat of size, and then staining them with burnt sienna and vandyke brown. The ingredients are mixed in water and the colour regulated according to taste ; the vandyke serves to darken the colour. The stain is applied with a sponge.

To stain oak in various shades leaving the grain of the wood visible—Common crystal soda solution applied warm will give oak the appearance of age. Ammonia will darken oak, and bichromate of potash, mahogany. Linseed oil will slightly deepen the colour; American potash will deepen it still more. Soda added to potash will give a darker shade.

To stain oak black, place a small quantity of logwood chips and copperas into an iron vessel, add a quart of water, and let it boil until reduced one half, then apply hot. Three coats will be necessary for a deep black.

For darkening mahogany without concealing the grain of the wood the following may be used :—

Limewater will deepen the colour. Common crystal soda dissolved in water will darken the wood. Alkanet root will improve the colour of a piece of wood. The stain is extracted from the root by steeping it in raw linseed oil for several days.

Bichromate of potash dissolved in water will also deepen to various shades.

Black Boards.

A good preparation can be made as follows :—Take a small quantity of dry *vegetable black*, add patent or other *knotting*, and mix them thoroughly in a clean can, thin down with methylated spirits, and apply it with a clean brush ; it dries quickly.

An old black board will require one coat only, but a new one should have three or four coats. The surface should be rubbed down between each coat with glass paper.

The above will dry with a dead black surface which will take chalk marks readily, and the latter can be easily rubbed off.

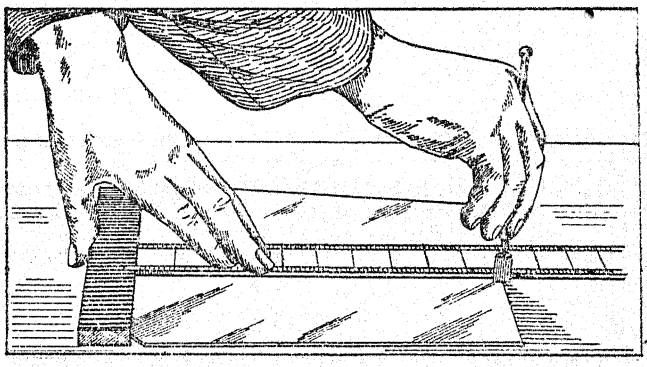
The brush will require to be washed in methylated spirits after using.

To Cut and Drill Glass.

Place the glass on a level surface, and the straight edge in the position required. The diamond should be held between the first and second fingers, the flattened part of the handle resting between the thumb and the inside of the second finger, and must be held at a certain angle to obtain a "true cut," which will be obtained as follows :—

Fig. 100.

Position A.



Place the diamond in position next straight edge with knob inclined slightly towards the wrist (*see* A, Fig. 100). Apply a slight pressure to the diamond, at the same time allowing the knob to incline slowly towards the wrist, when there will be a slight click (easily felt by the hand) indicating that the cutting point of the diamond has been reached (*see* B, Fig. 101) ; if the instrument is drawn across the glass at the angle obtained when the click was felt, a true cut will be obtained. A scratch can easily be detected

by its whiteness, and when only a scratch is obtained, the straight edge should be moved to the left of the scratch, so as to allow another attempt to be made. A second attempt in the same place tends to spoil the diamond.

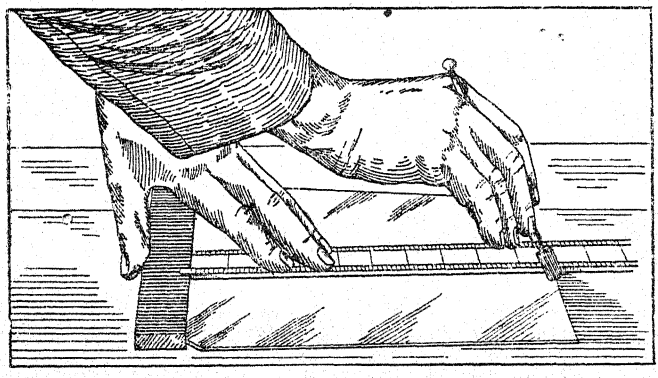
Glass which has been previously used should have all putty, &c., removed before attempting to cut it.

In cutting thick glass it is sometimes necessary to tap the opposite side of the cut to assist it through.

To drill glass use a carefully ground drill and a piece of iron the required size for a guide to the drill. If the glass is thick an ordinary carpenter's brace may be used; but a "fiddle" drill is preferable. Turps, in which camphor has been dissolved, will make

Fig. 101.

Position B.



a good lubricant. It will be found as soon as the skin is penetrated that drilling will be easy, but on entering the skin on the underside there is a risk of breaking it, due to vibration; this may be obviated by placing a piece of putty over the under surface of the glass.

Glazing.

New frames should receive a coat of priming before being glazed; the paint makes a "key" for the putty, which requires to be soft and well bedded in the frame. In applying or placing the glass, care should be taken that the pressure given to bed it in the putty is applied near the edges, not in the centre of the pane, or the glass may be broken. Large sheets of glass require to be secured with a few brass brads, after which the putty should be applied to the outside and bevelled off neatly. The putty forced out during bedding should be cut before leaving the work.

To make a Paste for Laying Cloth or Leather on Table Tops, Desks, &c.

Take 1 lb. best flour, two spoonfuls of well-powdered resin and one large spoonful of powdered alum ; well mix in a clean vessel, add cold water by degrees and stir carefully until the mixture becomes of the consistency of cream. Put it into a saucepan over a clear fire, keeping it constantly stirred so that it may not burn or get lumpy. As soon as it simmers, it is done. Empty into a pan and cover up until cold to prevent a skin forming on the top, which would make it lumpy. Apply with a short or stiff brush.

SECTION IV.

INSTRUCTION FOR SADDLERS AND SADDLETREE-MAKERS.

This part has been prepared by the Chief Inspector, Equipment and Stores. It contains general instruction for Saddlers and Saddle-treemakers under the following heads, viz.:—

1. Saddlery.
2. Harness.
3. Packsaddlery.
4. Miscellaneous Articles.
5. Repairs, generally.
6. Care and Preservation of Harness and Saddlery.
7. Saddlers' Materials.

I.—SADDLERY.

SADDLES.

There are five kinds of saddles in use in the Service, viz.:—
The Officer's, Universal, Driver's, Luggage and Pack saddles.

Officers' Saddles.

Mark III has a high brass cantle, solid seat, and V-girth attachments, and is worn with numnah pannels and blanket.

It is issued to R.A., R.E, and A.S.C.

These will be replaced, as worn out, by Mark IV.

Mark IV is the latest pattern for all officers. It has hitherto been known as the "Staff" pattern. The tree is similar to that used on a hunting saddle, but with side-bars extended behind the cantle, and

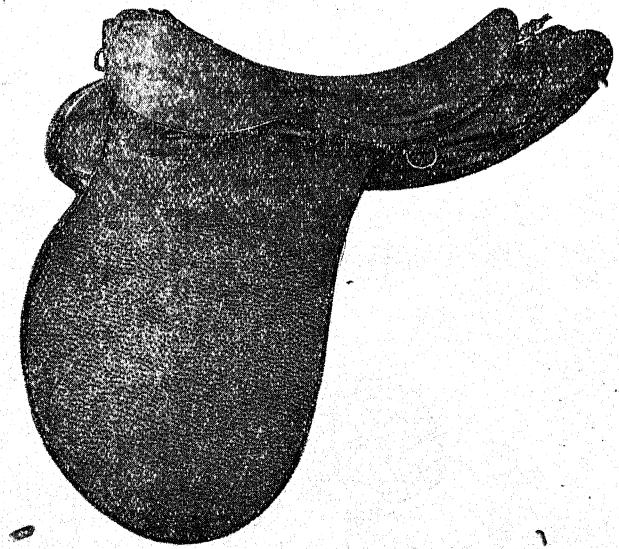
points of front arch broad in the bearings. Length of side-bars, 23½ inches large size, and 23 inches small size. The seat and skirts are of hogskin. The flaps are of solid leather, made without rolls. Length of seat, measured from extreme edge of front of cantle, about 17¾ inches. The pannels are leather (basil) lined, and stuffed with white wool flock. The dees and loops are of brass.

The saddles will be issued in two sizes—large for horses, and small for cobs.

A large saddle with 19 inch seat is made for exceptionally tall and heavy officers, when specially authorized.

Seat Length.—The position of wallets on the saddle greatly affects the working length of seat for the rider; they can be set well forward, as the continuations of the side-bars are well in front of the arch and will admit this. It can be done by setting the rear loop between the staples. It can be further altered by sewing the loops 1 inch nearer the rear edge.

Fig. 102.



OFFICER'S SADDLE.

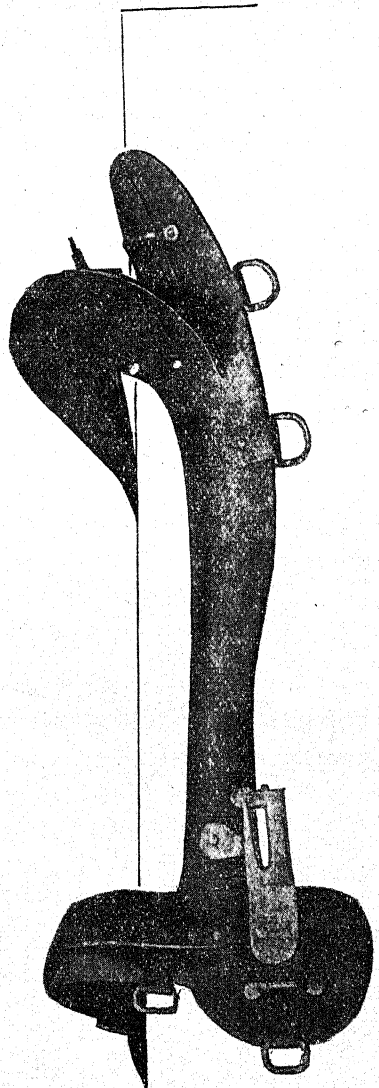


Fig. 103.

OFFICER'S SADDLETREE.

Position of Flaps.—When renewing flaps on Mark III saddle (brass cantle) they should be fitted more forward than in the earlier patterns.

The swell of the flap should be set $1\frac{1}{4}$ inch in front of the front point of the side-bar; the old staple hole should be sewn up, a fresh one made, and the cut-out part to fit stirrup bar enlarged if necessary.

The front edge of flap covering the bar, when re-fitted, should project $\frac{1}{2}$ inch over the front edge of arch.

This alteration may be made to flaps at present on the saddle if considered necessary.

Flaps on Mark IV saddles should be fitted so that the front edge of the swell of the flap is $1\frac{3}{4}$ inch in front of the front point or burr of side-bar.

The pannel flap should be stretched a little if necessary to suit the new position of leather flap.

Bridle heads are issued in two sizes for officers' and universal saddlery (large and small); and three sizes for harness use ("extra large," "large," and "small").

Head collars are made in two sizes for officers' saddlery, and in four sizes for other purposes ("special large" for heavy transport horses; "extra large," "large," and "small").

Surcingles are in two sizes ("large" and "small").

The girths are in long and short sizes.

The reversible bits are stored in three sizes:—small, medium, and large; "medium" size for horses, and "small" size for cobs; the "large" size, having a $5\frac{1}{2}$ inch mouthpiece, is principally for draught horses. This bit having cheeks parallel (not splayed at the top) must be wider in the mouth than other portmouth bits, to prevent the top loops chafing.

SADDLES, UNIVERSAL.

Indents should always show the sizes of saddles required. Size marks are shown on the front arch, "S," "M," or "L."

Percentage of Sizes.

——	Large.	Medium	Small.	——
Cavalry { Light	15	85	†	
Cavalry { Heavy... ...	30	70	†	
Mounted Infantry ...	—	—	100‡	
Royal Horse Artillery ...	35	65	—	
R.F.A., R.E., A.S.C., and Regimental Transport	50	50	—	

☞ A small percentage of "S" size will be issued when required.

‡ For cobs; but a small percentage of "M" size will be issued when required. When ordinary cavalry horses are employed a selection of "M" and "L" are necessary.

The respective sizes will be found suitable as under :—

The large for heavy horses.
The medium for horses in general.
The small for animals 15 hands and under.

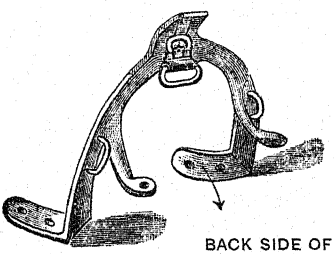
The absence of points to the front arch extending below the side-bars is compensated for by the action of the V attachment, and shorter side-bars which allow each side a wider range of fitting than previous patterns.

The steel arch saddles are known as 1890 and 1902 patterns, the former is in general use, a few of the earlier angle iron pattern are still in use.

See Fig. 105, illustrating V attachment.

Saddles, Steel arch, pattern 1890.—The arches are made of steel. The front arch is of channelled form. There are two slots on each side of the front arch for the wallet or cloak straps.

Fig. 104.



BACK SIDE OF HIND ARCH.

The hind arch (Fig. 104) has a curved spoon cantle, which is fitted with roller bar, for the centre baggage strap, and with two staples for the side baggage straps. Two struts riveted to the bars support the arch.

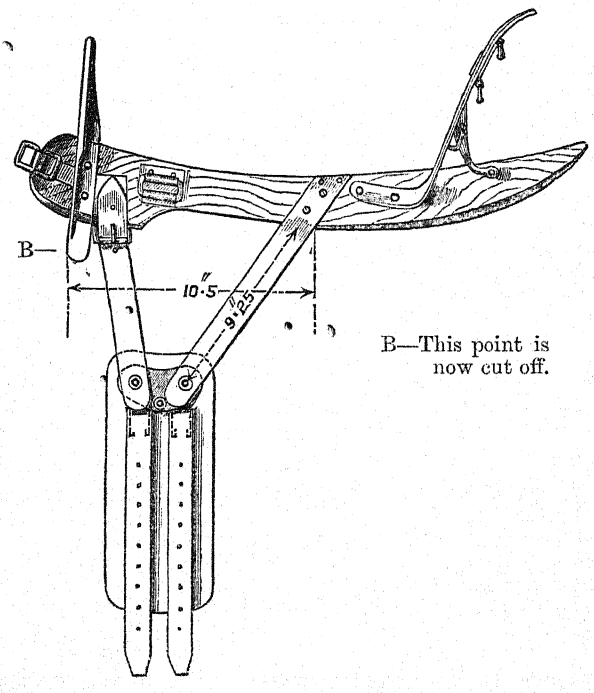
There is but one size hind arch for the three sizes of front arch ; the feet and struts have to be slightly adjusted to suit the bars for "S" and "L" size saddles ; as in the "L" size the position of these is further from the outer edge than in the "S" size, and the surface of the bars in consequence varies a little. If this adjustment is not correctly made before riveting, the bars will be drawn out of correct set, or possibly split in riveting.

The side bars are thicker and wider than those in the angle iron pattern ; and the edges are rounded. A link and brass roller for the attachment of the stirrup leather is fitted to each side-bar instead of mortises, so that there is no break in the smoothness of the under surface of the bar.

The wallet links are fitted to the upper surface of the side bars instead of on the front edges, as in the previous pattern.

The seat is of solid leather (the tree gives 17¼ inches before the seat is put on) and having its dip in the centre of the length.

Fig. 105.



V-attachment, for Girth.

This now has a brass plate to strengthen the part acting as a pivot to the straps.

When fitting this attachment to the saddle the artificer should buckle the front strap into the centre hole before screwing the long strap to the bar, to obtain the proper set. The measurements as shown (in Fig. 105) should be carefully maintained. The $9\frac{1}{4}$ inches is from the bottom edge of bar.

The upper ends of the attachment straps being set wide apart, prevents the saddle readily tilting to one side.

The attachment should not be worn as a true V, *i.e.*, the front and rear straps of equal length; such a set would drag the saddle forward, and depress the hinder part of saddle. It would be equivalent to fixing the girth to the centre of the saddle. The front upper strap is the true girth strap, the rear one being the steadying strap, but both should be set to take a fair bearing.

The upper straps are not to be unbuckled daily when girthing, nor utilized for making a girth that may be too long, or too short, suitable.

There are three holes in the front upper strap, the centre one being for the normal position of the attachment, it should be 6½ inches from the pivot of the strap; the upper and lower holes are provided for adjustment. No further lengthening or shortening of the front or rear straps can be made without detriment to the bearing of the saddle; therefore additional holes are not to be punched. The upper strap buckled in the centre hole will place the girth to suit a very large percentage of horses.

To adjust for animals having straight shoulders and shallow chests and that carry the saddle too far forward, the front strap should be buckled in the lower hole (worn short) and set to hang straight from the bar by twisting it and the rear strap on the rivets. This position will place the saddle as far back as is possible on such formation.

On animals that have deep chests and long sloping shoulders, and are rather thick in front of the saddle, which gives the saddle a tendency to work back, the front strap should be worn long, *i.e.*, buckled in the top hole.

Saddle, Steel Arch, Pattern 1902.—See Figs. 106 and 107. It has the same appearance as Pattern 1890. It differs from Pattern 1890 in the shape of the bars in front of the arch, and in having an angle steel hind arch with spoon riveted on and without struts; a staple or bar instead of a link is fitted for stirrup leathers.

The side-bars are thinner, being designed to be worn at all times with numnah pannels.

For repair, the altered Pattern 1890 front arch without points can be used.

The seat, flaps, pannels and V-attachments are interchangeable with Pattern 1890; the V-attachment has brass buckles, 1⅛ inch straps, and the sweat flaps have curved sides.

ADJUSTABLE RIDING SADDLE.

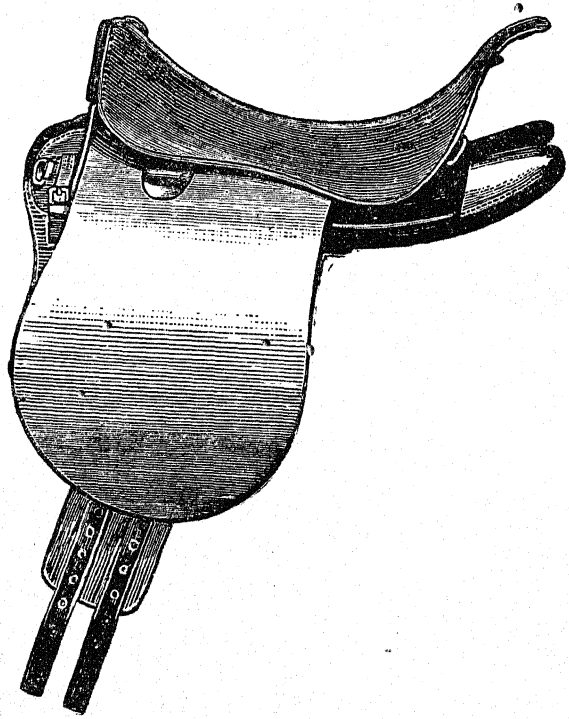
A saddle has been approved to supersede Pattern 1902, the Steel Arch Universal and Drivers' Saddles. It is made to suit horses and cobs, and will give one size for all Service purposes other than Officers.

The seat is a little longer, and the hind arch lower than Pattern 1902, otherwise the saddle has the same outward appearance; the Front Arch is held by clips, the Hind Arch by sockets. Struts are added to support the arch, strengthen the lower angles forming the feet and to prevent the arch working backwards out of the sockets. The seat is supported by double webbing from front to rear arch, to stiffen it particularly in wet weather, when the leather is very liable to stretch and become unshapely. The Flaps are buttoned on to steel studs in side-bars instead of being screwed to the bars.

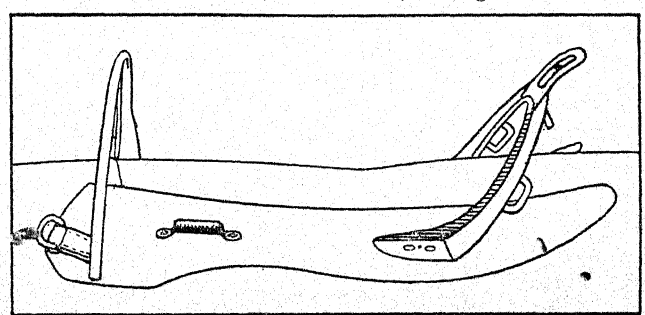
It is worn with numnah pannels and blanket.

The side-bars, arches, sockets, and steel-studs are special to this saddle.

Link and chape on hind pocket not shown. Fig. 106.



SADDLETREE. (Pattern 1902.) Fig. 107.



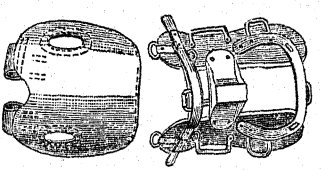
Drivers' Saddles.

At present there are steel arch and angle iron patterns. The universal steel arch saddles will, when stock of present drivers is exhausted, take their place, as shortening the side-bars, and cutting off front arch points (List of Changes §13942) adapts it for draught horses. One size "L," equal to "Large" size Universal, has in the past been found suitable for drivers' saddle for horses, and one size "Small" for cobs. The angle iron pattern affords two sizes "L" and "M" for horses.

Driver's saddles are now practically all fitted with numnah pannels instead of stuffed pannels.

Luggage Saddles.

Fig. 108.



These have iron arches, and are made in two sizes, the "S," small size, being for "mule harness" and "machine gun infantry," horsed with cobs or mules. The luggage saddles must always be worn with pannels. Numnah pannels of two thicknesses of felt are the latest pattern. Pads, luggage, R.H.A. Pannels, luggage pad, R.H.A.

Saddles Universal, and Drivers.

Size Measurements.

In consequence of the cutting off of the extension of the front arch below the side-bars, the bottom measurement of the front of saddle will be taken from the lower inside edges of side-bars.

The dimensions of the respective saddles will be as follows :—

Saddletree.	Size.	Across the top edge of the side-bars in front of front arch (outside measurement).	Across the bottom edge of the side-bars (inside measurement) front arch.	Across the top edge of the side-bars 15 inches from the front of the front arch.	Length of side-bars.	
		Inches.	Inches.	Inches.	Inches. Pattern 1890	Inches. Pattern 1902
Steel Arch, Patterns 1890 and 1902	Small ...	5⅞	10¾	5⅞	22¼	22
	Medium	6¼	11¼	6¼		
	Large ...	6⅝	11⅝	6⅝		
Angle Iron Arch Drivers	No. 1 or S	6	11¼	...	19½	
	„ 2 „ M	6¼	11⅝	...		
	„ 3 „ L	6½	12¼	...		
				Across the rear end of the side-bars.		
Steel Arch Drivers	Small ...	5⅞	10⅝	5	19½	
	Large ...	6⅜	11½	5½		

With ¼-inch deviation in each case.

PANNELS.

Officers' Pannels for Mark IV saddles.—These are leather-lined and stuffed with flock.

Luggage Hair Pannels.—Have the backs made with strained basil, and are lined with white serge, and stuffed with horse-hair.

They will be used for luggage saddles until stock is exhausted, then suitable numnah pannels of two thicknesses of material will be substituted for them.

Repair of Pannels.—A pannel occasionally requires re-stuffing on account of the old hair or flock having become hard, uneven, and caked ; and sometimes new lining, the old being torn and worn.

Numnah Pannels.—Each pannel is made of one piece of felt, and is furnished with a front and a back pocket for the reception of the ends of the side-bars. The front pocket is split and provided with a securing strap and buckle. For hollow-backed horses a second layer of felt can be added.

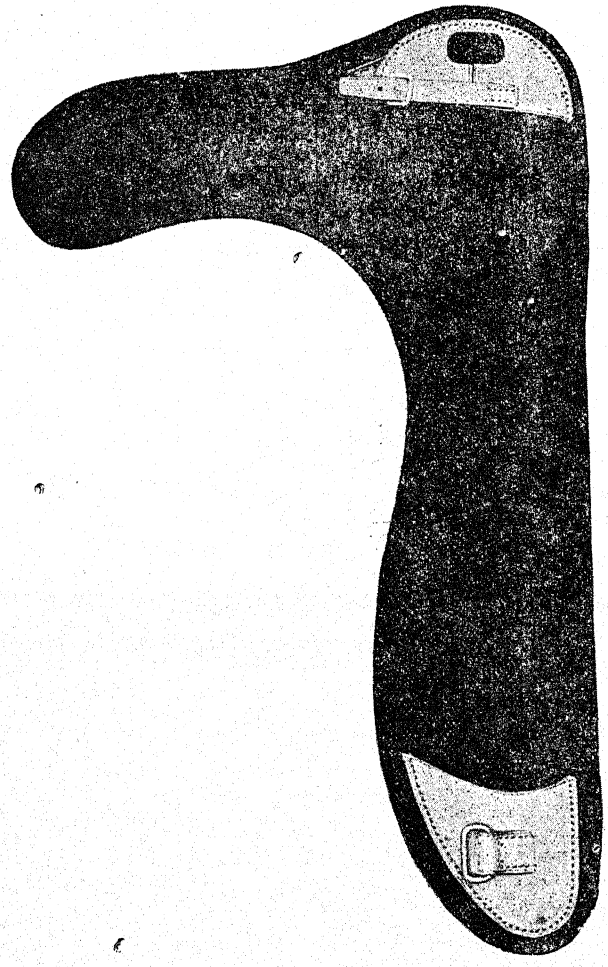
Front pockets that become unshapely or unsightly should be renewed.

The advantages of numnah pannels are :—

They give padding without blocking the channel of front arch, or space between the bars as a blanket does ; the side-bars do not get chipped so easily ; a surface is also afforded which grips the blanket ; they are formed to give knee pads ; they allow building up to alter bearings when necessary without interfering with the wooden bars ; moreover, when the blanket slips, they prevent the hard wood or iron of tree coming in contact with the shoulders of the horse.

Mark I* pannels are suitable for the pattern 1890 universal saddle. Mark III pannels are suitable for both patterns 1902 and

Fig. 109.



Pannels, Saddle. (Side Bar Strap not shown.)

1912 universal saddles. All universal pattern saddles are provided with numnah pannels.

To hold the pannel in position a small strap and buckle is sewn on in front of rear cap to buckle round the bar in front of hind arch. The exact position of this strap is shown in paragraph 15,978, List of Changes.

Saddle Blankets.

These are issued with all saddles for War, and are intended to be used, when required, as a covering for the horse in the field. For Peace, they are not intended to be used as a covering for the horse except in camp.

Repairing.—Repairs should be done with "worsted, grey," and with a herring-bone stitch, about five to the inch. The edges of the blanket should be drawn together and not overlapped.

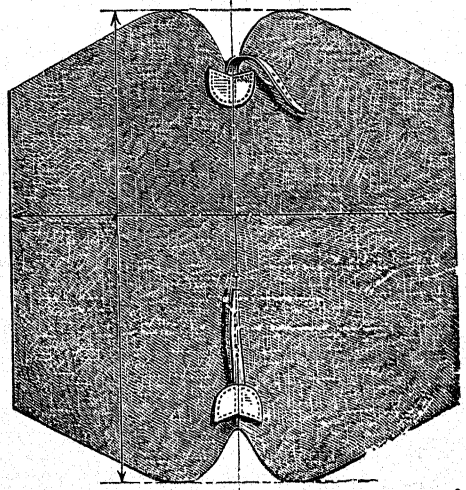
The stitching in all cases should be carefully executed so that the rent or patch when repaired may lie flat.

Torn blankets can generally be repaired without patching, but in a few cases a patch may be necessary. Material when used should, as far as possible, match the blanket.

Numnahs, Felt.

Universal.—This is issued for officers' saddles.

Fig. 110.



Luggage.—This is the same as Fig. 110, but with loops instead of straps.

Repairing.—When a numnah is torn round the patch, often caused by pulling it up into the saddle gullet when tightly girthed, it should be repaired with new and larger leather patches. The numnah is cut out in the gullet part, so that it does not require to be pulled up tightly to the top of arch—the old numnah was not so cut and required lifting.

Bits, Portmouth.

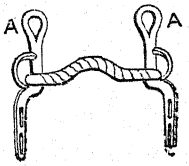
There is only one pattern of portmouth bit in use with saddlery and harness, viz. :—

Bit, portmouth, reversible.

20°/° of half-twist mouthpiece are provided.

The bridle head will be issued with the reversible bit to all services using the general service pattern head-collar. Army Service Corps harness has a special pattern head-collar, and therefore this bridle head will not be required for use with it.

Fig. 111.



The reversible bit has no bottom bar, nor rein rings, as in the general service pattern. The mouthpiece is not rigidly fixed to the cheeks, and consequently the latter can be reversed. For the 20°/° one side of the mouthpiece is grooved as shown in the woodcut (Fig. 111), and the other is smooth. The rough side will be used for hard-mouthed horses, and the smooth side for others.

The cheeks of this bit are parallel (not splayed at the top), the mouthpiece must be a size wider, in consequence, than other pattern bits, to work well in the mouth and to prevent the top loops chafing.

Two reins will be issued for each bit except for harness purposes.

Bits, Bridoon.

The one for officers has tees to secure it to the head-collar.

Head-Collars.

Officer's Head-Collar.—This is of a special pattern. It is made of bridle leather, and has brass buckles, rings, &c.

Head-Collar for Harness and Saddlery.—This is used by all services.

The Mark IV head-collar has brass buckles and nickel rings.

Head-Collar, A.S.C.—It is fitted on the near side of the nose band with a buckle, to allow it to be readily adjusted to varying sizes of heads. It has a small strap and buckle on each side to carry the bit. The one for the bridoon is much higher on the

cheek and is not suitable for a portmouth bit attachment, as it would bring the squares inside the loops of the bit cheeks. A bridle head will not be issued with this head-collar. This head-collar is obsolescent.

Stable Head-Collar.—Although held on barrack charge, is to be kept in repair by artificers, the same as other articles of harness and saddlery. It should be worn without the brow band on horses that slip the collar. With very restive horses, a strong neck strap would have to be made from annual material, as has been customary in the service. Rivets, buckles, and squares, &c., are allowed for repair; should there be insufficient rivets, stitching must be resorted to in special cases.

Reins.

Old pattern bit reins had a wedge in the hand part; the later ones have been joined by a lap over, the same as the bridoon reins. All are now issued as "Reins, Bit," and will be issued for either bit or bridoon with saddlery.

Shoe-case with Sword Frog.

A tube with strap is fitted to the front.

The securing strap for sword buckles round the scabbard above the rings; it is attached by a tab, to allow it to act on the shoe-case strap as if it were a loose strap. This strap must not be riveted to the shoe-case, as it would draw in the upper part of scabbard, allow the lower part to project, and by the leverage of the latter cause the front of the shoe-case to be torn.

Lamb and Leopard Skins.

These are for use with officers' saddles. They have leather seats and moleskin linings. The facings are obtained regimentally and are to be sewn on by the regimental artificer.

Officers' Wallets.

They are constructed with double gussets and have waterproof covers. Each pair is connected with a leather band, and each wallet has a leather loop at the back. A pistol loop is formed in the "off" wallet, and an ammunition pocket in the "near" wallet.

The bindings are the only part that will be likely to need renewing with leather. The leather used should be carefully selected and shaved thin and the stitching carefully executed.

Girths.

There are two patterns for officers' saddlery, one of blue web 3¼ in. wide for Mark III saddles fitted with V-attachments; the other is for Mark IV low cantle saddle. Two form a pair, one being 5 inches in width and the other 2⅞ inches, of blue web.

There are three patterns for harness and saddlery in use. One is of leather, known as "luggage" pattern, 48 in. in length. The other of leather, for saddles fitted with V-attachments, viz. universal and

drivers, and is issued in three sizes, 26 in., 31 in., and 36 in. The third is of cord, for Cavalry only, of similar length to the V-attachment patterns.

Girth Straps.—The 1¼-in. girth straps are obsolete; only 1-in. straps can be used with present patterns of girths.

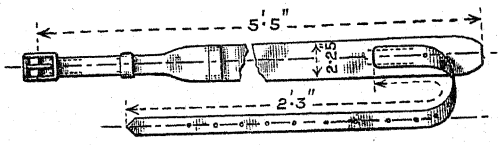
Surcingles.

Officer's surcingle is of a special pattern.

The saddlery surcingle (*see* Fig. 112) is used with all existing pattern saddles. The buckle must be kept in the middle of the girth, and not at the side, to allow the narrow part to lie over the split part of the girth.

A small size is issued for cobs.

Fig. 112.



Large size 7 feet 1 inch over all; body 5 feet 5 inches.
Small „ 6 „ 7 „ „ „ „ 4 „ 11 „

Buckets, Rifle, Cavalry.

Mark II.

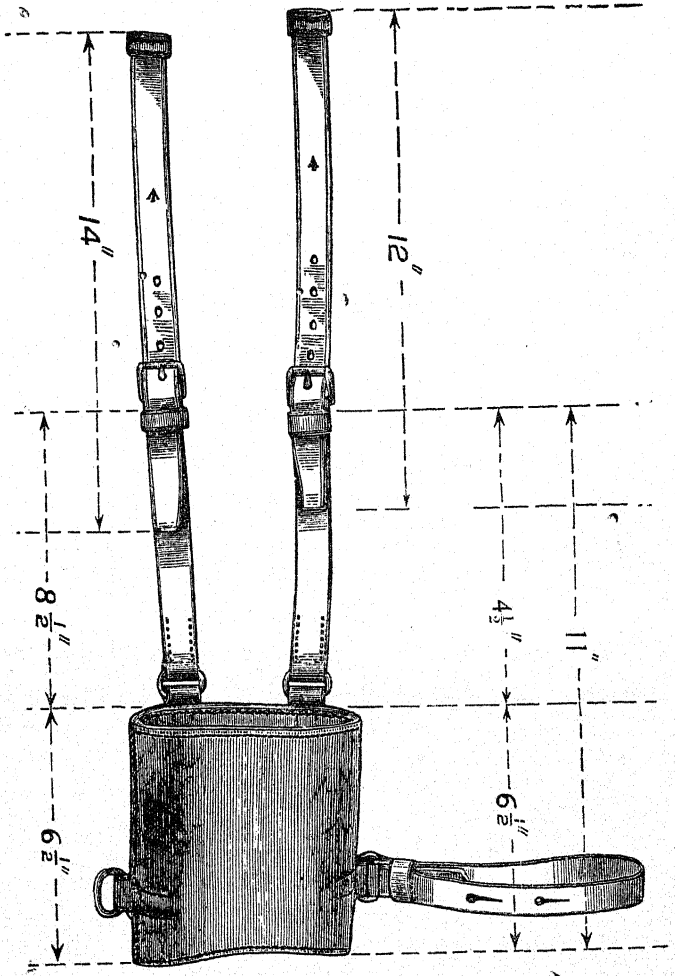
Mark II bucket (Fig. 114) is of crop (sole) leather, and should not be dubbed as other leathers are; hard soap properly applied is sufficient to keep it in good condition; beeswax used occasionally in addition is not objectionable. It has a steel plate at the top (strap side) to stiffen the part to keep it clear of the sights when drawing and returning the rifle. It will be issued for cavalry only until the stock of Mark I is exhausted.

Should the arm close to body be weakened by repeated bending, an addition of leather should be sewn on in some cases inside and in others outside to stiffen. The stitches at this part should be renewed immediately if broken to save further damage.

See page 131 for further instructions for repair and care of this article.

Mark I pattern is of soft dressed leather and is obsolescent.

BUCKET, RIFLE, MK. IV.
Fig. 113.



This pattern is issued to Mounted Infantry and others as ordered.

The above (Fig. 113) shows the old length of straps on the left, and the new lengths on the right, as ordered by List of Changes.

Marks II and III have bodies 8½ in. in depth, which require the buckle pieces shortening accordingly.

The body of this bucket is frequently crushed by strapping it flat to heel posts and in other ways. This flattening forces the bottom out of shape, and causes the bucket to become prematurely unserviceable.

Very thick straps should not be cut to replace the stay straps.

Ropes, Head.

Rope, head, cotton.—The officers' pattern is fitted with a buckle and leather billet, and is not intended for picketing.

Rope, head, hemp.—This is 10 ft. long, of 1¼-in. hemp rope, with a ring in one end.

Saddlery Traces.

Traces for breast harness are 8 ft. 6 in. long, made of 2 in. rope with an iron ring spliced in the front end, and an iron hook spliced in the rear end. The front end is covered with leather for a length of 4 feet.

The traces are used in conjunction with breast pieces on riding horses to adapt them for draught in the lead in cases of emergency.

Household Cavalry Saddlery.

A part of this saddlery is of special pattern, black, and a part the same as the cavalry of the line, viz.: saddle, stirrup leathers and irons, wallets; straps, cloak wallet; centre cloak, and baggage; saddle blanket, shoe-case, carbine bucket, cape or cloak protector, numnah pannels.

Fitting the Saddle.

In fitting the saddle to the horse's back, the points to be considered are: the side-bars, arches, and padding to be employed.

Side-bars.—The side-bars should suit the curve of the horse's back, and bear evenly throughout their length to within 2 inches of the extreme rear points. A space of from 3 to 4 inches in width down the centre of the back between the bars should be free. The cross web for protecting seat from saddle-pin should be long enough to prevent bearing on the back.

If the outer edges of the side-bars unduly bear, allowing the fingers to be passed along the inner edges, the saddle is too small.

If the inner edges bear unduly, showing the outer edges clear, the tree is too large.

A smaller or larger size tree, if available, should be employed.

But saddletrees which show these deviations from the perfect fit may, in many cases, be used with suitable padding, and carried without injury to the back.

If the saddletree does not rock when the hands are placed on the front and rear arches to test it, the curves of the bars are suitable.

If the animal has a hollow back, and the side-bars bear on the front and rear ends only, the saddle may be made to suit by adding a piece of felt, 10 inches in length and tapered at the ends, to the centre of the numnah, or stuffed pannels intended to be used with the saddle.

If the animal has a straight back, and the centre of the bars only show a bearing, the ends being off the back (this fit would rock) a shorter piece of felt should be attached in front of the centre of pannels, and in some cases in rear and in other cases front and rear, leaving 6 inches of the centre clear.

The pieces may be attached to pannel by a few spot stitches.

Arches.—The front arch should now be considered to see that it stands sufficiently off the withers to clear them in use when the padding is added, to give not less than two fingers' breadth, that they place the side-bars in a suitable position each side the withers. How far the front arch should stand above the withers must be determined by the pattern of saddle, the shape of the withers and shoulders of the horse, the class of padding to be used, and due regard to a level seat fore and aft for the rider when the saddling is completed.

If the saddle is too low in front the rider will be thrown on his fork, and if it is too low behind, his knees will work up and his weight be thrown too far back.

If the steel arch saddles were fitted to touch the withers of any but extreme high-withered animals, the rear part of the saddle would be cocked up, and the seat would not suit the rider, and no space would be left over the withers for the blanket.

With the Officers' or Yeomanry pattern saddletrees which have low front arches, the arch though touching the withers when the saddle is fitted to the back without pannels, may be sufficiently high off the withers when fitted with its pannels.

The points of the front arch below the side-bars are useless on saddles fitted with V-attachments, and should be removed if they interfere with the fitting of the tree, particularly on horses with coarse, lumpy shoulders, which are often met with in draught. These points should not stick out, nor grip unduly, and in fitting it must be remembered that they will be shifted two inches higher on the shoulders with the saddle by the padding which will be used.

Saddle Drivers and Universal now have these points removed.

Padding.—Stuffed pannels give much thickening under the bearings of the points of the front arch; they fill up the space under those that project, and to those that fit apparently may give too tight a bearing.

There is a considerable difference in height of the front arch above the withers when stuffed pannels are on the saddle to when the tree only is on the back. The use of stuffed pannels makes the difference of one size in the saddle fitting.

Numnah pannels, and blanket, do not cause the same difference.

The rear arch of steel arch saddles will be found to clear the back well, but saddles of the Officers' and Yeomanry type having a low

span require particular attention when thin pannels are employed to see that they are clear of the back.

Adding pieces of felt (numnah) to the numnah pannel or other pattern pannel is a quicker and more serviceable plan to meet all service conditions than cutting out fresh side-bars and practically making a new odd saddle which may eventually get on a horse for which it is totally unsuited. In fact, this has frequently been found done.

The standard side-bars will fit all horses if a suitable size is selected and a little adjustment of padding is made.

It is the general suitability of the side-bars to the back of the animal, the arches spanning the back sufficiently high, that gives the bearing and fit and makes the saddle suitable, rather than a close grip of the front arch.

But a well-fitting saddle will not give freedom from sore backs if the load is not carried fairly square and level on the back, so that the side-bars and pannels bear evenly along their length, neither tilted right nor left, front nor near.

Short stirrups will place the weight of the rider too far back in the saddle, causing the weight to press unduly on the loins of the animal, forcing the saddle forward and allowing the saddle to tilt readily, causing wither galls.

Instructions for Saddletreemakers.

The repair and alteration of saddletrees are the duties of the Saddletreemaker or Wheeler.

He should frequently examine the saddles in use for loose or broken-headed rivets, replacing or tightening them up; timely repair will prevent bars breaking.

The gullet plates of Officers' saddles require very great care in replacing; old holes in the wood may require stopping and new holes carefully drilled.

The Officers' new pattern saddletree has side-bars of thin beech wood, covered with linen, and stiffened with steel plates, similar to the hunting pattern. This class of bar is formed with less curve from front to rear, and much depends on the padding for fit and serviceability.

New Side-bars.—These should be shaved so that the thickness may match the one already on the saddle; if the old one is thicker than the more recent bars issued for repair, both bars should be renewed.

The bars of Pattern 1902 saddles have the front burrs or points more squarely shaped than previous patterns, and are smoothly finished; new bars should be similarly shaped in front to match, and if necessary the plate and wallet staple removed to admit this being properly carried out.

The curve and twist of side-bars suitable for the Service saddles has been determined after 50 years' use, and the bars issued have this shape. Experienced saddletreemakers should be able to detect

a wrong bar, many of which have got into use on active service with serious results.

The feet of the hind arches require slightly resetting to fit the three sizes of saddletrees. It is normally set to "M" size. It is necessary to adjust the struts in some cases to prevent them resting too near the inner edges of the side-bars. A badly-fitted hind arch in riveting up draws the bars out of the correct position.

Packsaddle bars when in the rough are difficult to distinguish as near or off, but by comparing the new bar with the existing one and noting the twist, and the front curve of bar, which is much sharper in front than in rear, a decision can be made.

Tacking or nailing felt (numnah) to the under surface of the side-bar is strictly forbidden, as it damages the bars and renders them liable to split, the tacks cannot all be drawn out again when removing the felt to make the saddle suitable for other horses; glue attaches felt more securely and would not be objectionable, but neither course is necessary, as the pieces required can be stitched on the felt or hair pannels.

Oil and varnish should be applied to new bars before the saddle is completed with its leather work.

The instructions for fitting saddles are set out in the Saddlery Part and should be thoroughly understood. *See also* Sizes, page 81.

2. HARNESS.

The composition of the several descriptions of harness is shown in Equipment Regulations, Part I.

With the exception of harness for Infantry machine guns and mule breast harness, the normal harness for all purposes will ultimately be "Pole Draught General Service," neck collar or shaft draught being arranged for by the issue of special articles.

"Harness, A.S.C." as a pattern is obsolescent, but full particulars regarding it will be found in "Amendments to A.S.C. Training, Parts I. and III.," issued with Army Orders dated 1st July, 1914.

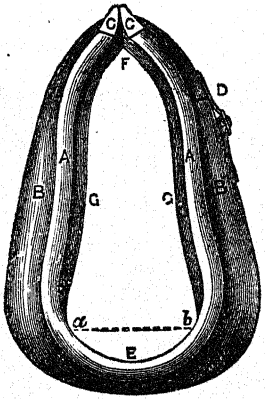
COLLARS, NECK. (*See* Fig. 114).

Neck collars are of two patterns :—

1. Those for ordinary draught horses.
2. Those special to heavy transport horses.

The first mentioned range in size by ½-inches, from 20 inches to 25½ inches—the others by 1-inch, from 23 inches to 27 inches. The latter differ from the former in having a wider bearing surface at the "draught," and also in having an additional lining of basil, with flock for stuffing, added to the usual body side.

Fig. 114.



The technical names of the various parts are as follows :—

A. Fore wale.
B. After wale.
C. Caps.
D. Strap.
E. Throat.
F. Neck.
G. Body side.

The size of the collar is determined by measurement from E to F. Its size should be marked with $\frac{1}{4}$-inch stamp at the bottom of the collar on the after wale, about 2 inches from the stitching, and 1 inch from the outer edge. Size marks worn out should be renewed. Collars shortened or lengthened by artificers must be re-marked according to their new lengths.

Neck Collars.—It is important that the collar should fit properly; it should be sufficiently large to admit the fingers between it and the horse's neck on each side, and the flat of the hand between it and the throat. If the collar is too large it will be constantly moving about, and, getting over the sides of the shoulders, will soon produce galls; and if it is too small it will have a tendency to choke the horse when "in the collar." (*See* False Collars, page 126.)

The hames should be taken up sufficiently to sit well in the groove formed by the fore and after wale without closing the sides of the collar.

Re-lining.—Unstrained basil is used for this purpose as it allows much stretching in filling, but strained basils may be used should unstrained not be available. The lining should be cut to a paper pattern to save waste.

Plugging.—This may be done to a collar weakened in the throat by careless use, or to one that requires a little stiffening in the body.

The after wale should be taken off and the tops closed; the lining made wet (but not the straw, which would swell); all the lacing stitches should then be pulled up tight. The first plug should be put in through the straw three inches from the centre of the throat on one side, and the second one at a similar distance on the other side, the plugs passing each other, and so on alternately to strengthen the throat.

If the body part of the collar requires plugging, continue by inserting plugs three inches apart until the tops are reached.

N.B.—The plugging iron should be put into the body first to make a place for the plug, and kept as near the back of the collar as possible.

Pieces for repairing the fore wale when chafed by the long rein should never be shorter than 4 inches, to allow the under edges to be properly skived. While repairs are proceeding, the breast collar can be used as a substitute.

Pads, Collar, Zinc.

These are made in two sizes, large and small, and stamped with the letters L and S accordingly. They measure $6'' \times 3\frac{1}{2}'' \times 5\frac{1}{2}'' \times 3\frac{1}{4}''$ respectively. The pad in some cases shortens the collar one size.

Percentages of Sizes.

Pattern and Size.	For Neck Collars.		For Breast Collars, R.A., wheel.	Remarks.
	Up to 23½ inches.	24 inches and upwards.		
Mark II, { Small	100	—	100	Large size will be issued for 23 inch and upwards until stock is exhausted.
Mark II, { Large	—	100	—	

N.B.—To prevent damage and undue wear when in use with breast collars, the pad straps should not be exceptionally tightened to bend in the ends of the pad, nor should the pad be bent in to touch the front and back of the neck collar.

Hames.—The pattern of hame for all services is "Hames with rings." It is made of steel or wrought iron, and is connected at the bottom with a detachable chain, which can be taken up so as to make the hames fit different sizes of collars. The sizes differ in inches, from 22 to 26.

The hame chain is fitted with a kidney link and a ring for the reception of the pole chain for use in pole draught.

The hames are connected at the top by a leather strap passing through the top eyes.

A qualified smith will have no difficulty in repairing or correcting the set of the hames.

The Service Hames with detachable hame-chains will fit any Civilian pattern or Service collar. The size of hame need not necessarily correspond with the size of collar. Each service hame will generally fit a collar two sizes below or above its own marked size, Civilian pattern pipe-collars excepted. A pipe-collar being closed at the top and V-shaped at the throat, necessitates a full sized hame being used, so as to place the draught-arm sufficiently high.

Harness, Pole Draught, G.S.

Rapid release attachments are employed to facilitate hooking in and unhooking the horses in a team. The attachment is applied to the neck piece and pole bar and traces. It consists of a steel bent link, fitting into a suitable link on the object to be connected, the two links being held in position by a strap.

The Breast Collar takes the place of the neck collar and hames, the pole bar is employed to stop the limber as well as to support the pole; the pole bar is held up by the neckpiece, and the breast collar by the neck strap, both working in the zinc collar pad on the neck.

The R.F.A. have riding saddles for both near and off horses, the R.H.A. riding saddles for the near only, and pads for the off horse.

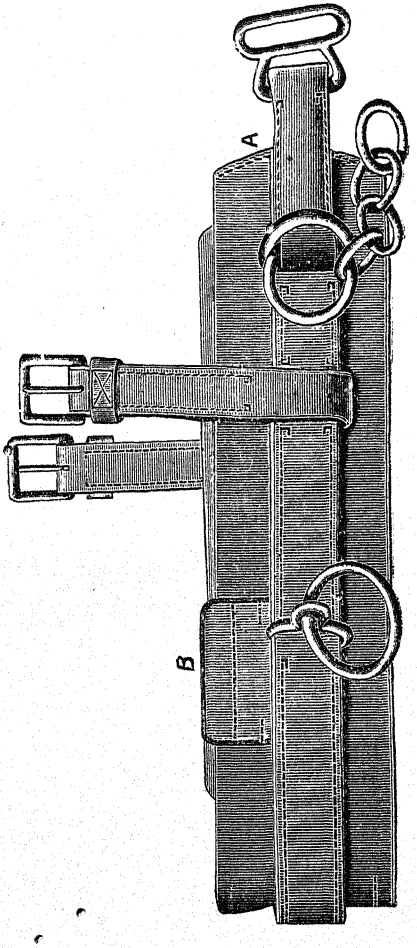
Wire Traces will be used throughout the team when the stock of rope traces is used up, but until then long wire traces are only allowed for the wheel pairs.

Special Traces, designated "Traces, wire, wheel," are approved for Heavy Batteries, to relieve the excessive strain on the wheeler's breast collar and to allow four pairs of traces to act on the limber independently of each other. (*See* page 104.)

When neck collars are used with this harness, connection between the hames and traces is made by means of "Traces, chain, hame attachment; and the polebar is supported by attachments, hame, supporting polebar," one to each hame hook.

"Collar, breast, Mark III."

Fig. 115.



This differs from Mark II (§ 13400) in having wire-lined tugs for trace attachment, and 2-inch by 2-inch dees in place of 2-inch curved links. Safes or patches are sewn on near the shackles and links, to take the bearing of the steelwork of neckstrap and prevent friction on the folded upper edges of the collar (*see* instructions below with reference to safes and wire in tugs in repair). Copper rivets have been added to strengthen parts.

Repair of Mark II Breast Collars.

When the trace tugs of Mark II breast collar are much worn they should be repaired as follows :—

One piece of wire issued for trace repair, 4 feet 2 inches long, should be taken and one of the six strands removed; with this a grummet of four lays should be made, well and evenly twisted, with the ends spliced. A thimble as issued, 1-inch by 1-inch, must be used at each end.

To obtain an even twist, the wire after once passing through the link and ring should have free ends of equal length, both ends being twisted backwards equally. The grummet to be lapped from ring to link with a waxed thread, and afterwards covered with a selected piece from the butt of heavy collar back.

Two 2-inch by 2-inch dees are to be sewn in the collar to carry the tugs, in lieu of the 2-inch curved links which attach the worn tugs.

Care is to be taken to retain the correct length of the tug, which, when finished, should be as shown at (A) in drawing.

Dees for battery for repair are issued and thimbles.

The 4 feet 2 inches of wire will give sufficient for three pairs of tugs.

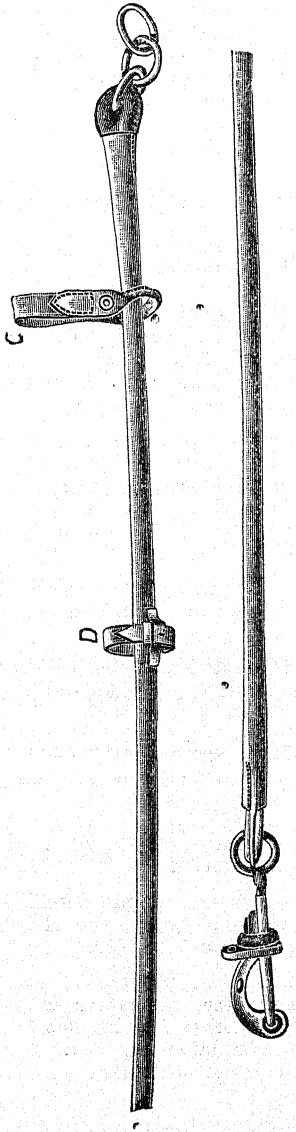
The wire and leather required will be taken from the annual allowance of material.

Two model grummets will be lent to guide this alteration, one to show the method of forming and splicing and the other the lapping with waxed thread.

Should the upper edges of the breast collar split from the friction of the neckpiece, patches or safes 3¾ inches by 1¾ inches, as shown in (B) of drawing, should be added, the split being first neatly drawn together. The rear edge of patch to be set 1 inch behind the shackle.

"Trace, wire, wheel."
(Off side.)

Fig. 116.



This differs from the "Trace, wire, long," used in wheel, in being one length of wire, fitted at the rear end with a modified G.S. trace hook to allow it to be hooked in the link on existing swingletrees.

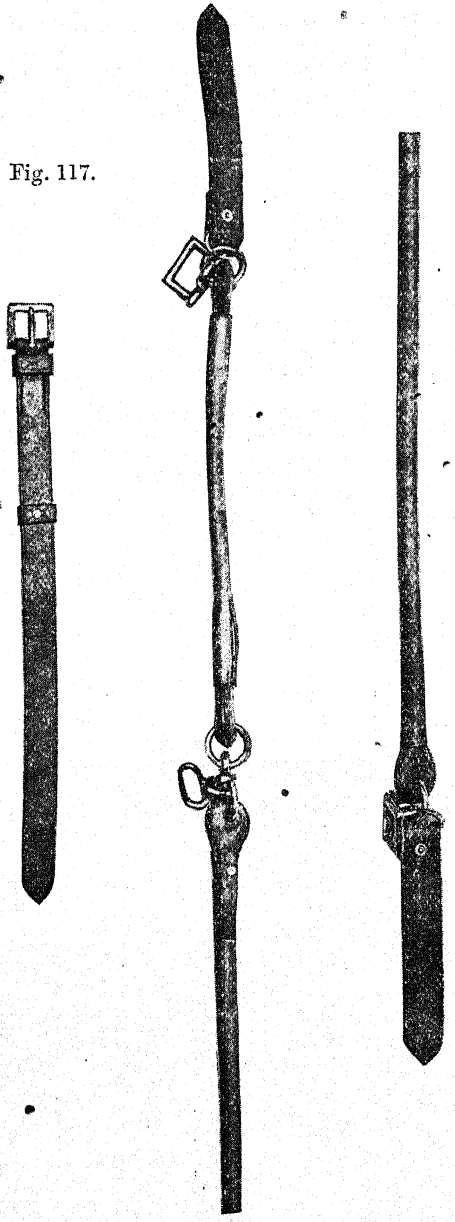
This trace is approved for heavy batteries only, for use, in addition to present long traces, in extending the traces of the centre pairs to the swingletree to relieve the excessive strain on the breast collars of the wheel horse, and to allow that horse to have its own trace. When in use, four pairs of traces act on the limber independently of each other.

Short wire traces in lieu of short rope traces will be issued for the pair immediately in front of wheel to reduce the weight to be supported by the breast collars of the wheel horses. Rope traces in other cases will continue to be used until stock is exhausted.

The bearer (C) is worn over the trace tug of the wheel horse's breast collar, the small strap (D) being buckled round the trace.

When casting off the breeching and long traces to release the wheel horse, it is not necessary to separate the new wheel traces; the whole can be taken off together.

Fig. 117.



Trace, Wire, Long, with Tug.

Fig. 118.

NECKPIECE, POLEBAR.

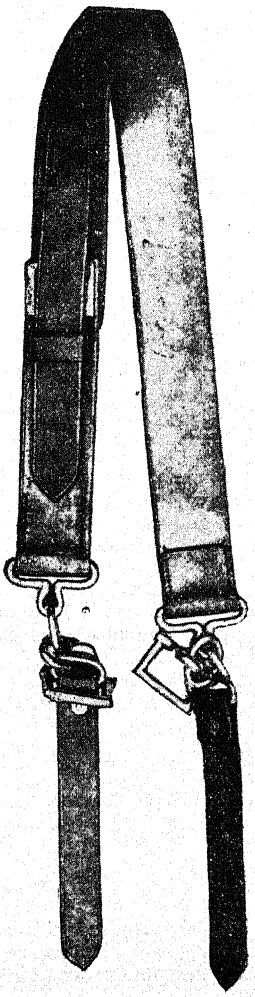
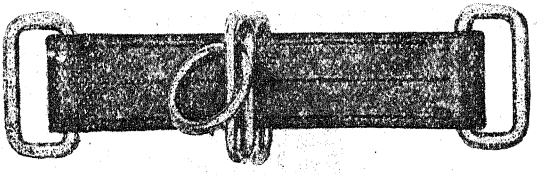


Fig. 119.



TUG, NECKPIECE, MARK II.

The "Neckpiece, polebar" (Fig. 118) supports the polebar, to which it is engaged by quick release attachments.

The "Tug, neckpiece" (Fig. 119) must be used in conjunction with it, and the P.D.G.S. breast collar with G.S. or other wagons fitted with pole chains or straps attached to the point of the pole.

The tug is to be attached to the ends of the neckpiece after the bent links of the latter have been passed through the side rings of the breast collar.

Short traces for extending traces are issued. P.D.G. short traces have a special hook at one end and a releasable link at the other end.

The wheeler's traces should be of such a length that when he is in the collar his quarters may be about 18 in. clear of the swingletree or splinter bar, and the lead traces should be of sufficient length to prevent the possibility of the horses striking their feet together when moving at a gallop; the horses should never be nearer than 3 ft. from nose to croup. It is sometimes found necessary with short horses to cut the traces shorter, but if afterwards they have to be lengthened it must be by putting in new ropes. The rope allowed annually will not meet constant shortening and lengthening of traces. It should therefore be rarely resorted to.

Extreme lengths of the respective traces, including links and hooks, are :—

P.D.G.S.	Long Wire	5 ft. 6 in.
„	Short Wire	3 „ 2 „
„	Wheel Wire (Heavy Batteries) ...	6 „ 5 „
„	Adjustable, Wire	overall length, adjustable from 5 ft. 3 in. to 5 ft. 7 in.

Repairs to Traces.—The wire rope requires a longer splice than the hemp rope; the strands of the hemp grip each more firmly when tightened up under strain than do the smooth strands of the wire rope.

The wire splice should not be shorter than 5 inches, and a metal thimble is necessary to give a wider bend and less friction. Rope should have a leather thimble in the traces.

The hemp ropes of traces should be spliced to the swivel chain or link by tucking each strand twice and finishing the ends smoothly but not too short.

The wire rope should have each strand tucked under three times.

The splices to be lapped for further security, and in the case of the wire to prevent the sharp ends cutting the caps or pipes.

The hemp in the wire rope is to give pliability and prevent friction between the strands, and should not be removed when splicing or making grummets.

In capping the leather should be damped and neatly sewn on and edges finished; the pipe is prevented from turning round by being sewn to one or both ends.

Drivers' Leggings.

There are two patterns, Mark I and Mark II; the former will take the place of the latter when stock is exhausted. It is made of leather, with an iron side plate, and is used to protect the driver's right leg from the off horse and pole or shaft.

No soft spongy part of leather found to be so frequently cut by units should be used to replace the straps, and care is necessary to retain shape of plate when riveting.

Extending Pieces.

For extension of harness purposes, the following articles are stored—

Girths, pieces, extending—for extending girths. They are buckled to the existing girth straps.

Breechings, straps, extending—for extending existing breeching straps; and "neckpieces, polebar."

Surcingles, straps, extending—for extending surcingles; neck-straps; and "straps, hip, long, wheel.

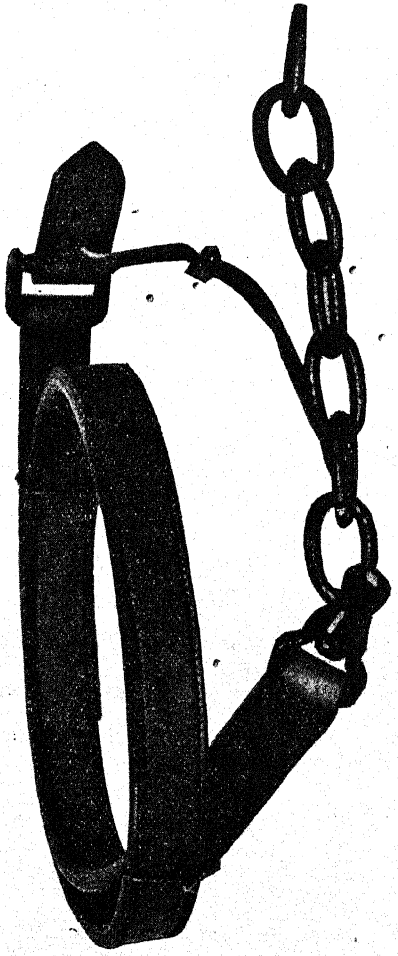
Mule Harness.

The Service Mule Harness is known as ten-span. It is arranged that it can be used as 2, 4, 6, 8, or 10 span, by using as required Swingletrees and Trek chains.

The Sets are shown in Equipment Regulations.

Traces.—The earlier pattern Traces were buckled to the breast collar and were weak from the punching of the leather and cutting action of the tongue of the buckles when the traces were wet. Chains for linking into the breast collar hooks have been sewn in to obviate this.

Fig. 120.

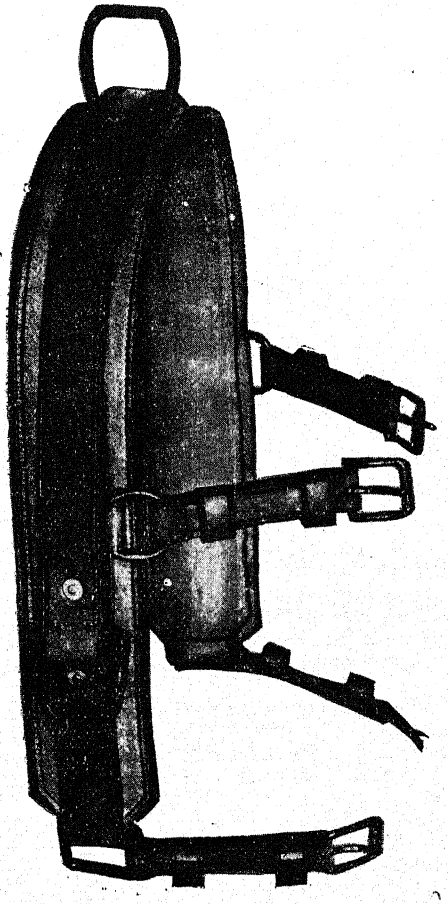


TRACE WHEEL.

Breast Collar.—A special hook similar to that in front of the A.S.C. trace, but with a longer turnback point that does not require ties, is fitted to take the chain or trace.

COLLAR, BREAST.

Fig. 121.



3. PACKSADDLE EQUIPMENT.

There are two principal packsaddle equipments in use, viz. :—

(*a*) Artillery.
(*b*) General Service.

(*a*) Artillery.

There are different saddles specially fitted for each part of the equipment, viz. :—

Saddle, Ammunition.
" Axletree.
" Carriage.
" Gun, breech.
" Gun, chase.
" Spare wheel and axletree.
" Wheels.

Each saddle consists of one saddle (formerly designated cradle) and two pannels.

Saddle.—B.L. 10-pr. Each has two steel arches connected by two wooden sidebars, and two steel side rods, top and bottom ; the sidebars project beyond the arches and have square ends.

The sidebars are connected by a wide piece of leather to prevent any small article falling between the pannels and the animal's back. Each vary in other particulars to suit the special load.

Pannels.—Each pannel consists of leather and collar cloth, stuffed with horse hair. The stuffing can be re-arranged, when necessary, through an opening in the outer side, which is covered by a leather flap. Leather patches with slots for straps allow of attachment to side-bars.

Crupper.—This is an ordinary leather crupper, buckled on to a strap, which is secured to the saddle by a wooden toggle.

Girth.—The girth is of 4-in. worsted web, with leather lined ends with D-shaped holes for the girth straps to pass through before buckling. It is 42 inches in length.

Fig. 123.

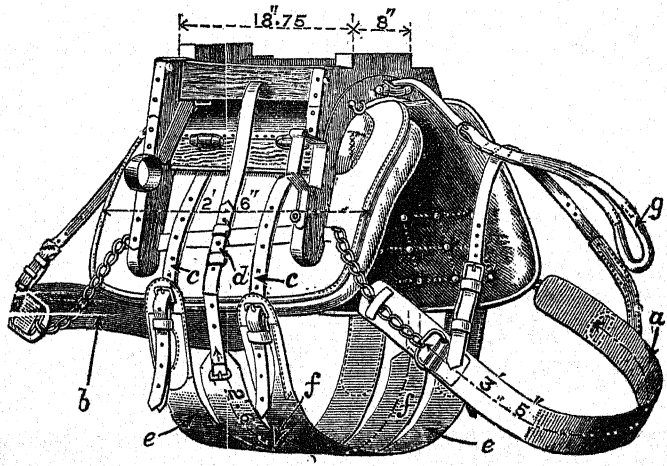


Fig. 123, above, shows R.M.L. 2·5 in. carriage saddle, and breechings, &c. Saddles of this equipment are being converted to B.L. 10-pr.

Straps.—The following 1½-in. straps are required, viz. :—

Strap, girth, 24 in. long, four per saddle. This is a plain strap doubled, with a wooden toggle sewn in the centre to prevent its slipping through the slots in the cradle.

Surcingle, web.—The surcingle is of 4-in. hemp web with 1½-in. straps at each end, for attaching it to the surcingle straps, which are secured to the saddle.

Collar, breast.—The collar is similar to the breeching, it has a neck strap, 1 in. wide. and 34 in. long.

Breeching.—The breeching is of seat or bag hide, folded three, with a leather chape sewn at each end for the D, and chains by which it is attached to the cradle. Two leather tugs with buckles are sewn on the front, for the hip strap, which passes through a loop on the crupper.

The hip strap is 1¼ in. wide and 40 in. long.

Note.—The special articles herein detailed are supplemented by other straps, head-collars, bits, and reins, to form complete sets. A proportion of the general service packsaddlery and harness is also required to complete the packsaddle equipment of a battery. A certain number of breast collars and breechings have been modified by the addition of a "lay-on," and the substitution of steel dees and chains of a larger wire gauge for the lighter iron dees and chains, for use with the "Draught Attachment."

Racks, Intrenching Tools.—These are of leather, "Near" and "Off," each 2′ 8″ × 2′ 1¼″, fitted with leather loops, pockets, and straps for the attachment of intrenching tools. The racks are connected by a leather strap near each end at the top. Each rack is provided with an iron loop and link 7½ in. from each end, and 7½ in. from the top for the attachment of the racks to the saddle.

Draught Attachment.—The following articles are provided to admit of the packsaddlery being used for shaft draught purposes. When fixed in position before the commencement of a march, shaft draught can be quickly improvised, and there is no necessity to remove them from the saddle and shafts when pack carriage is resorted to :—

Chains, draught attachment.—Consists of four short lengths of chain, attached each side to the ends of a thick leather connecting piece, with strong billets which buckle at the top, round the front, and rear arches of saddle. Each two short lengths of chain mentioned above are made V-shape, and connected to a single chain by welding to a ring. The single chain, which is made to hang as flat as possible, connects by the desired link to the centre hook of the "bellyband with tugs." In the case of wood saddles

the middle screw in the arches is removed to allow the billet to pass under the arch.

Belly band with tugs.—Is in two parts, *i.e.*, the buckle and strap portions, which join under the animal's belly.

The upper end of each portion is formed into a tug with a buckle and shaped billet, into the thick part of which is sewn the lower division of a double link. The upper division carries three hooks—the centre hook to attach to the single chain of the "chain, draught attachment," and the end links to the chains of breast collar and breeching respectively. The billet alluded to above passes through the fixed staple before buckling round the shaft.

Flaps, protecting.—These are made of leather, and strap or tie to the lower stay rod of saddle, the straps or thongs of the pannel engaging with them before fastening in the ordinary manner.

(*b*) General Service.

The latest G.S. packsaddle is designated 'Tree, Adjustable."

It will supersede the Large and Small sizes of former patterns, and the various Machine Gun and Ammunition Saddles.

The arches of this saddle are jointed to the side-bars to admit of their turning automatically, to adjust themselves to the backs of large or small animals, and to meet the loss in the condition of the latter which takes place on active service.

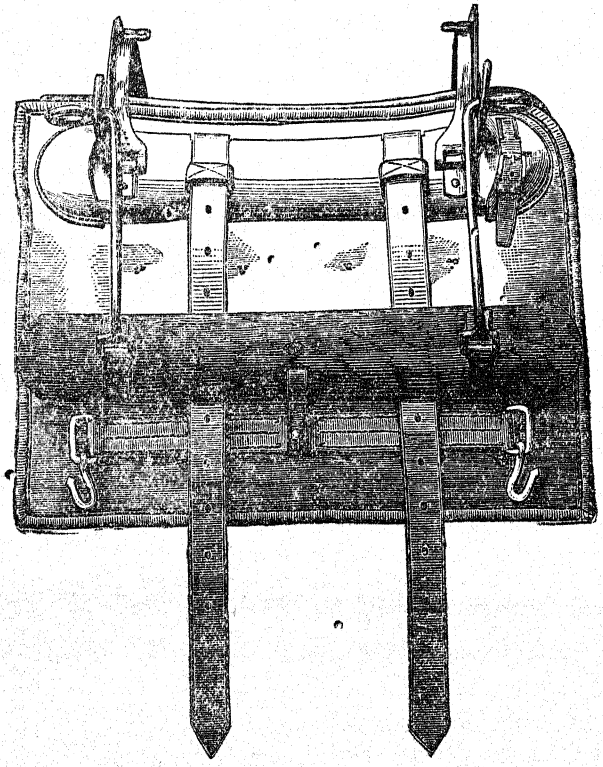
The arches, hooks, loops and plates are of steel.

The side-bars are of sabicu wood, 20 in. in length by $3\frac{3}{4}$ in. in width, curved and twisted. They are so set on the arches, that when turned horizontally the distance from edge to edge is 6 in. across the front and $7\frac{1}{2}$ in. across the rear, and when turned that the upper edges are as close to the arches as possible, $7\frac{1}{4}$ in. in front and $8\frac{3}{8}$ in. in rear.

To adapt this saddle for Machine Gun purposes, each arch is fitted inside the crown with a horizontal fixed loop to engage in the standing staples of the "Frame, wood, Mark II." This frame is for carrying the tool box on the gun saddle when the hangers are attached, and the belt ammunition box on the ammunition saddle when the racks are carried on the hooks. The latest racks are of tan canvas.

PACKSADDLE, G.S., WITH HANGING BARS.

Fig. 124.



BARS, HANGING.

Two form a pair ; they are suitable for any purpose that requires lower bars on the saddle, and will suit the same service as the large size G.S. pattern with lower bars.

They differ from "Bars, side, hanging" L.C. (§ 9608), in being 22 in. in length by 3½ in. in width, instead of 19½ in. by 4 in.

The steel arms are 8⅝ in. in length above the bars ; they are bent to hang on the saddle hooks, eyes being formed to project beyond the hooks to take the hooks of the cacolet (*see* drawing), and

when for other loads the twisted links are to be hooked on the arms, the eyes falling below the hooks.

Each bar has now a hole in the centre to attach the narrow leather girth in place of the small strap shown in Fig. 125. The arms have small straps not shown in Fig. 125 to keep the cacolet or racks, intrenching tool, in position on the lower bar.

Frame, Wood (*see* Fig. 125).

This frame, Mark II, takes the place of the heavy steel top plate riveted to the saddle arches, and the detachable "Frame, Mark I," which is fitted in it to take an ammunition or tool box.

It is formed to carry the spare part box (size about 19½ inches by 8½ inches), or the belt ammunition box (size about 15½ inches by 7½ inches).

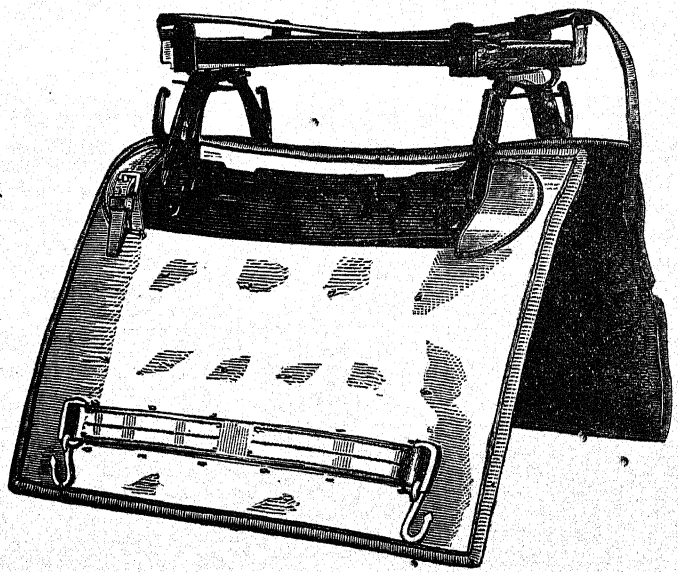
The Mark I frame is all wood; this is wood strengthened with steel plates, fitted with standing staples on the underside, and two small steel wedges for securing the frame to the saddle. One long strap with buckle piece is sewn to the ends for securing the tool or ammunition box when carried.

The frame, Mark II, should be attached to the tree by engaging the staples in the loops on the crown of the arches, the two small wedges of frame being passed through the staples and the pins passed through them.

It can remain on the tree as a permanent attachment as long as the saddle is required for machine-gun purposes. (*See* Fig. 125.)

It should not be detached and carried about strapped to the box.

Fig. 125. Packsaddle, G.S., with pannels. (A)



Pannels.

Mark V differs from the Mark IV (§ 6538) in being much lighter, and in having tan dowlas linings in place of white duck.

All G.S. pannels when re-lined will have this tan-coloured dowlas.

The pannels are fitted with links to take the straps of the Mark V breeching, and hooks to the links for the chains of other pattern breechings.

These pannels are also suitable for Marks III and IV pack-saddles.

Breeching.

Mark V differs from the Mark IV in having a 3-fold leather body, 2 inches wide, in place of a solid piece 3 inches wide; the ends are fitted with straps and buckles, in place of dees and chains, for attaching them to the pannels.

Collar, breast.

Mark V differs from the Mark IV in being 2 inches wide in the body instead of $3\frac{1}{2}$ inches. It is fitted with straps and buckles, in place of dees and chains, for attaching them to the pannels.

Crupper.

This Mark V differs from the Mark IV large in being lighter and in having a 3-fold leather dock unstuffed.

It will be issued in lieu of large and small.

Ropes, baggage.

These are of $1\frac{1}{4}$-inch Italian hemp, stronger and lighter than "Ropes, Mark IV," which are of $1\frac{1}{2}$-inch white cotton. They have less leather piping than the previous pattern.

Straps, baggage, will not be issued with ropes.

Girth.

Is of tanned worsted web 4 inches by $41\frac{1}{2}$ inches. Two for each tree.

The previous pattern was made of ordinary linen web, $3\frac{1}{2}$ inches wide, and each pair is joined together by a connecting piece, which is provided with a loop in the centre for the surcingle to pass through (Fig. 126).

Fig. 126.

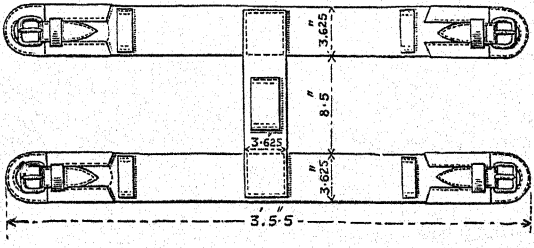
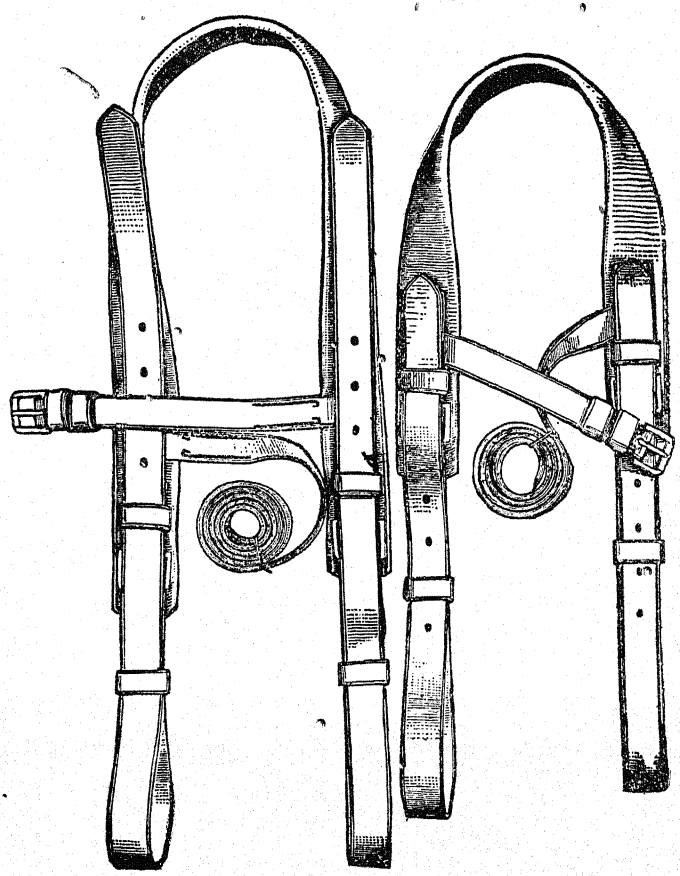


Fig. 127. Breeching. Fig. 128. Collar, breast.



The earlier General Service patterns are as follows :—

Packsaddle, Large.
" Small, Mark II.
" Large / Small } Mark III.
" Large / Small } Mark IV.
"

Packsaddle, Large size (was practically old Mark I).

Has 4 beech side-bars 21 inches in length, and horizontal hooks 17½ inches apart.

Mark II Small size (this was converted from Mark I Small). It has 4 beech side-bars 19 inches in length, and vertical hooks 14 inches apart.

The breechings and breast and head collars of the above pattern are of tanned circular web. The pannels have canvas backs and duck fronts, and padded with straw and hair.

These articles and saddles are not interchangeable with Mark III, &c., they will only be issued as sets or parts for maintenance.

Mark III Large size has 4 pedouk or sabicu side-bars, the upper 21 inches and the lower 23¾ inches in length, and horizontal hooks 17½ inches apart.

Mark III Small size has 2 pedouk or sabicu side-bars 20 inches in length, and vertical hooks 15¼ inches apart.

Mark IV Large and Small size trees are the same as Mark III except that the arches are of steel, and the flange for attaching lower bar is forked shape.

Marks III and IV pannels have leather backs and duck fronts (latter one tan dowlas fronts) and are stuffed with horsehair.

Marks III and IV head collar, breeching, and breast collar are of leather with chain end attachment to the two last mentioned. Most of the buckles and furniture is now tinned.

Fig. 129. Large Saddle.

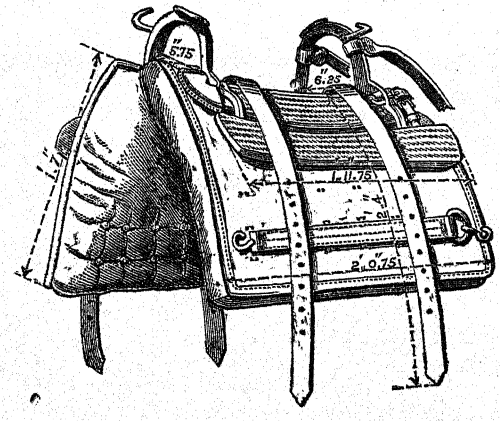
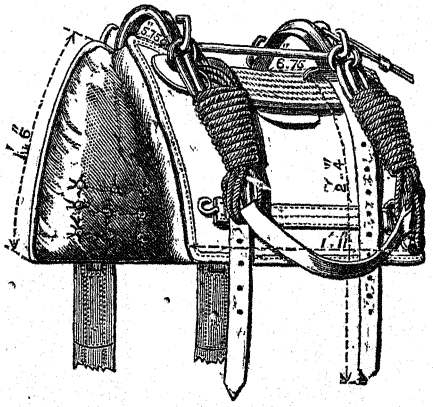


Fig. 130. Small Saddle.



Bit, Bridoon.—This is an ordinary bridoon bit, but tinned to prevent it rusting. The mouthpiece measures 5 or 6 ins. across, and is fitted at each end with a tinned ring to receive the iron stops on the Preller's hide rein.

The T-piece has a slot 2 in. from the end, and is secured to the rings with a $1\frac{1}{4}$-in. link and a swivel at each end.

Rein, Leading.—This is made of Preller's, known also as Crown and Helvetia, leather, and measures 9 ft. 4 in. long by 1 in. wide. It is fitted at each end with a tinned iron stop, 4 in. long, to secure it to the rings on the bit.

Collar Chain.—The chain is the universal pattern 5 ft. 2 in. long.

Surcingle.—This is made of web $3\frac{1}{8}$ in. wide, 10 ft. 11 in. long, and has a lay of leather along each side.

Baggage Straps.—These have a cross strap 5 ft. 10 in. in length and a buckle piece 2 ft. $2\frac{1}{2}$ in. in length, attached to a connecting piece, which is made to slide on the straps. Two straps constitute a set. These are only issued for very special cases.

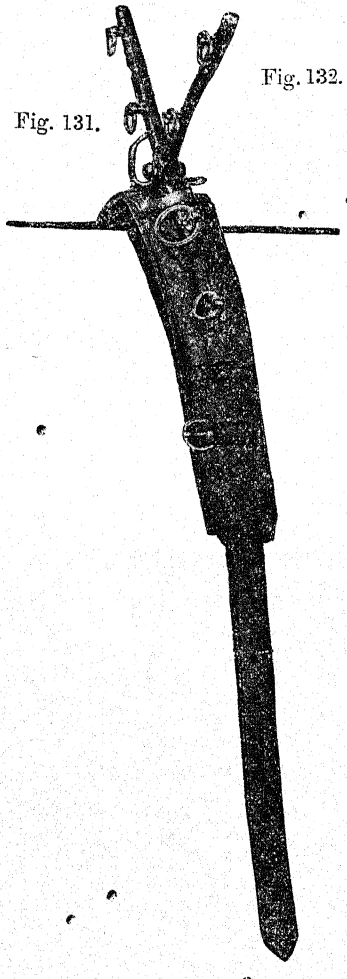
4.—MISCELLANEOUS ARTICLES.

Equitation Articles.

These are to be kept in repair by the Saddler, using the annual issue of material.

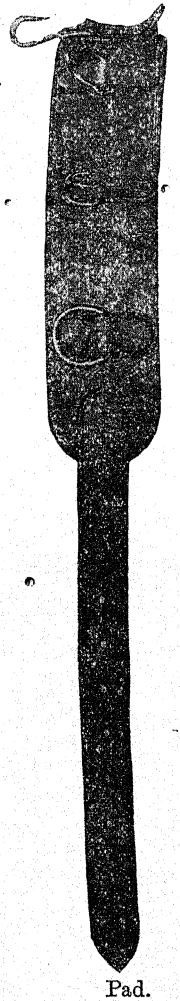
A few of the latest articles are shown below (Figs. 131, 132 and 133).

Fig. 131.



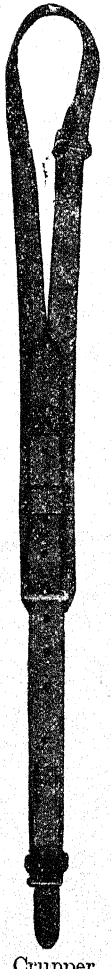
Crosstree.

Fig. 132.



Pad.

Fig. 133.



Crupper.

Fig. 134. Rein, Rubber.

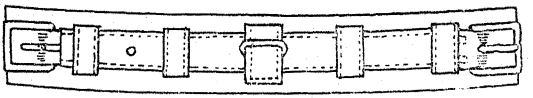


Fig. 135. Girth.

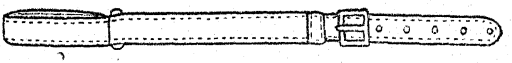


Fig. 136. Strap, Throwing, Short.

Crosstree.—This is of steel, jointed in the centre to allow it to fit large or small animals. The arms require careful stitching when re-covered.

Crupper.—This has two releasable attachments.

Girth.—This is the same for the pad and crosstree.

Reins, Running.—Used as bearing reins or martingale with crosstree or pad, and for riding.

Reins, Cord, and Web driving and breaking are for the same purpose, but the former is for draught horses.

Rein, Rubber.—This is used in conjunction with the bearing rein on pad or crosstree. It requires new whip cord when much used.

Pad, Vaulting.—Is of 5-inch tan web, about 71 inches in length strengthened with steel plates and fitted with steel, leather covered, hand-grips. The buckles for its girth straps are solid nickel sunk bar pattern.

Slings, Horse.

There are only two patterns now in use, viz.:—"Sling, horse, veterinary Hospital," and "Sling, horse, sea transport," the former is shown in Figs. 137 and 138.

The body is of canvas, the suspender of steel, the remaining parts are of leather, having steel fittings. The waterproof protector to complete is not shown in Figs. 137 and 138. It is issued to be worn on the seat of breeching.

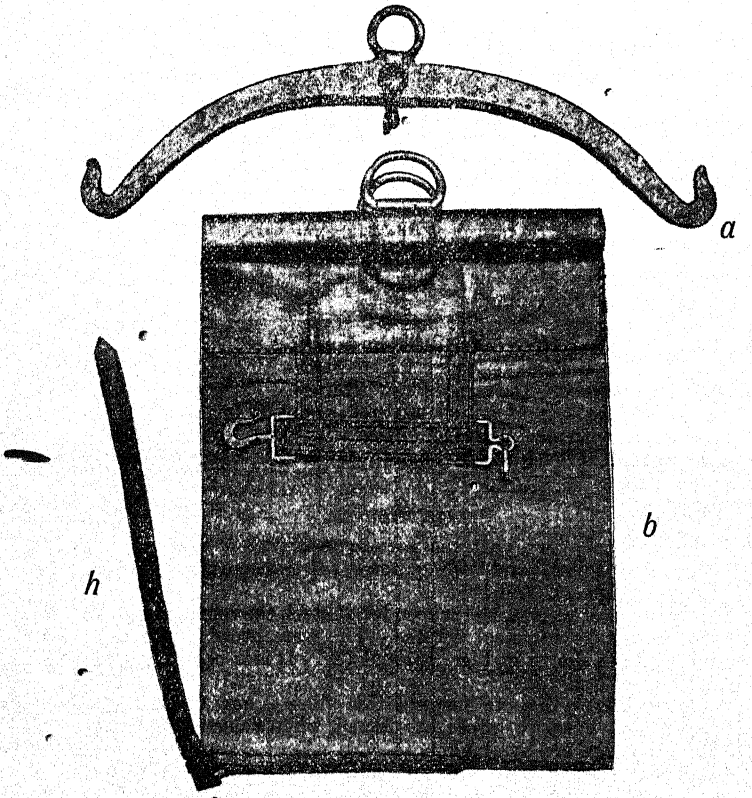
A differential pulley to suspend this sling is now fitted in sick horse stables, but two ropes are issued, when demanded, for use when pulleys are not available.

The Sling, horse, sea transport, consists of a canvas body and tarred rope fittings, two large loops being formed on the wood bars to suspend by, and one rope in front and one in rear to act in place of breeching and breastpiece. This is used by the Admiralty for shipping horses, and in the Service for transport practice.

SLING, HORSE.

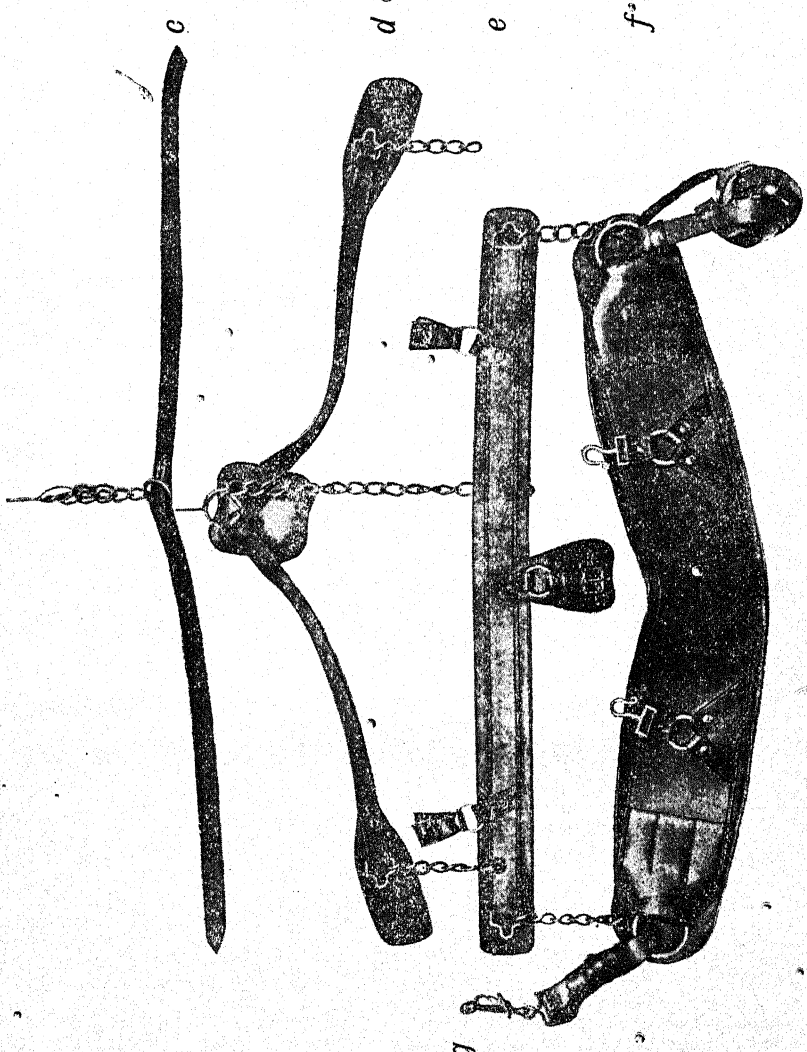
VETERINARY.

Fig. 137.



(*a*) Spreader. (*b*) Body. (*h*) Strap, connecting.

Fig. 138.



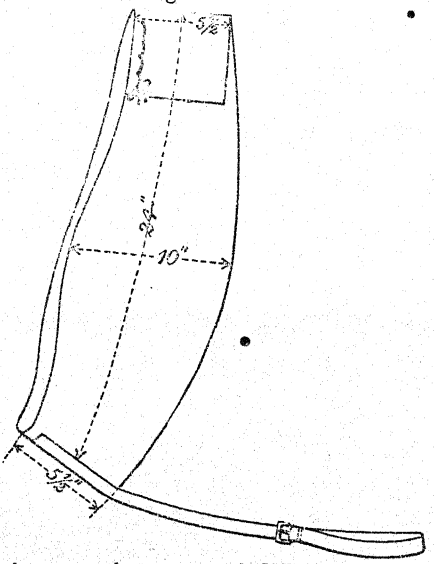
(*c*) Suspender, Breast-piece. (*d*) Suspender, Breeching.
(*e*) Breast-piece. (*f*) Breeching. (*g*) Hook.

A selection from the undermentioned articles is sometimes made by artificers at the discretion of the Commanding Officer of the unit before going on the line of march. Some authorities consider the last four, *i.e.* (*e*), (*f*), (*g*), (*h*), sufficient for all purposes.

(*a*) Collars, false, leather.
(*b*) Leather collar pads.
(*c*) Speedy cutting boots.
(*d*) Brushing boots.
(*e*) Pieces of blanket for brushing boots.
(*f*) Galling pads.
(*g*) Pieces of numnah, shaped.
(*h*) Ties, leather, of sorts, 3 or 4 dozen.

Collar, False (Fig. 139).—This can be made of bridle leather, light collar-back, or light hide. It should be cut to turn over at the top and punched that it may be secured by lacing; it can then be adjusted to fit the various sizes of collars. This collar has been used to advantage on tender-skinned horses; but on horses whose

Fig. 139.



collars are too large, or that answer indifferently, a numnah one might be worn temporarily, if pads mentioned below do not answer.

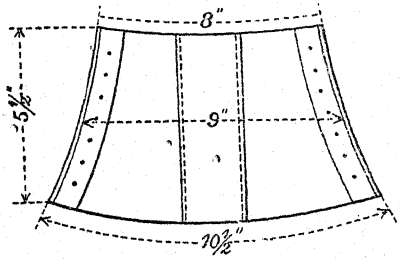
Leather Collar Pads.—When pads are necessary, pieces of shaped numnah with skived ends may be placed inside the collar and attached by lacing; but pads made with basil and stuffed with flock and secured by small strap and buckle, may sometimes be effectively employed.

Chambering a collar should be the last resource, as it is a very difficult task afterwards to restore it to its normal condition.

A breast collar (not saddlery breastpiece) used for a few days when possible in place of the neck collar, will be found the best remedy for a bad collar gall.

Speedy Cutting Boot.—This is used to save shin blows. It is generally terminated "shin" boot. If cut about the circumference of leg and drawn fairly tight with a strong lace, it will not turn when in use.

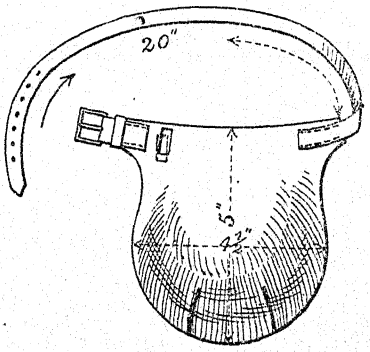
Fig. 140.



It may be made from numnah or blanket with three pieces of leather sewn on as shown in drawing (Fig. 140). A leather one of light hide, same shape, but with a soft tongue under laces is also suitable.

Brushing Boot.—This may be cut from shoulder, bridle, or light collar-back leather. It should be cupped by stitching or blocked to shape. A hole punched to admit the strap to pass through for a second turn round leg before buckling, will prevent it turning when in use (Fig. 141).

Fig. 141.



A piece of blanket or felt is frequently used on troop horses in place of a brushing boot. The piece should be cut 10 or 11 inches

in length by 7 inches in width. It may be secured round the leg by a stout lace or string above the fetlock, part of the blanket being turned down over the string to a depth of 3 inches, leaving the underpart 4 inches deep, or as desired.

Galling Pads.—A few small pads or shields, to tie on to the trace chains or hooks may be made of scrap leather, sheepskin, or numnah, with a leather tie.

Numnah Pieces, shaped.—These may be about 9 inches in length. by 4½ inches in width, skived at the ends very gradually for inserting inside the front of a numnah pannel, or to attach by lacing to the front under side of side-bar to raise the front arch when necessary. Glueing numnah on side-bars makes the addition as hard as the wood. Tacking it destroys the side-bars. For neck collars longer and wider pieces may be tied inside the neck collar to change the bearing when there is evidence of a tendency to gall.

A piece of numnah 4 inches in depth by 6 or 7 inches in width may also be found useful under the V-attachment sweat flap should the iron dee gall, care being taken to attach it so that the lower edge is above the dee. It should not be under the dee, but above or below it, or both. If so done, the piece will take the bearing of flap and stirrup leather, and prevent the pressure of dee on the animal's side.

Ties, Leather.—*See* page 134, "Leather," which describes how made.

5. REPAIRS, GENERALLY.

Breakages or damages sustained by harness and saddlery should not be allowed to accumulate; they must be made good as they occur.

A certain quantity of spare harness, saddlery, spare parts, and material for repair is carried by all mounted corps for war service. For a battery of R.A. the spare harness and saddlery are carried on, and the spare parts and material for repair in, the "Wagon Store, R.A.," or on Limber.

Saddle Seats.—The web for seats issued is part strained, but requires additional straining. (*See* notes above.)

The web should be carefully fitted to meet the shape of the seat, so that leather and web act together, care being taken in driving the necessary tacks to prevent splitting the bars.

Flaps, Riding Saddles.—When replacing them on the saddle, the latest position should be followed, the front edge of flap at the swell being about one inch in front of the wallet dee. This can be obtained by dropping the top edge of *rear part of flap* $\frac{1}{4}$-inch below the top edge of bar.

Thread.—The made thread should be of suitable thickness, 3, 4, or 5-cord, or stronger if necessary, to match the threads in the article, and should be well twisted and evenly waxed.

Awls.—The awl employed should not be too large for the thread; a large hole weakens the part and lets in water. A small hole filled with a well-waxed thread is waterproof, and the thread is strengthened and preserved.

Edging and Creasing.—The edges of straps and patches, &c., should be removed, well rounded, rubbed, and creased, to give a finish equal to the new article.

Splicing.—The ends of the straps to be spliced should be skived evenly and so graduated that when the two parts are joined they give the thickness of the other part of the strap; to get this the splice should not be too short.

Nosebands and backstays should only be spliced when it can be done by a chape on the squares. Heads, throat lashes, &c., should not be spliced over the holes; the issue of leather is more than sufficient to allow the splice to be made away from the holes at the top of the head in the case of a head collar, and in one nearly new a complete long side of head, or a new throat lash, should be made.

Loops.—They should be blocked with a loop stick, and edged and creased properly. Care should be exercised when stitching in a loop to see that it is well secured in the stitching.

Buckles.—It is important to use the correct buckle for the strap or part. They are designated long leg, short leg, double, or single, barred, roller, bent heel, &c., &c. Too large a buckle gives too thick a tongue and allows too much play to the strap. A strap

of the thickness of the collar head will stand 9 cwt. strain at the part not buckled, but the action of the tongue of the buckle on the same strap reduces the strain to one-third and so in proportion with other straps.

Dees and Links.—A link is preferable to a dee, as the latter gives a curved bearing on the strap and wears the edges quickly, but the shape is favourable for some articles and it allows a little necessary lateral play to the strap.

Cutting Out.—The length of strap required should be marked out on the leather with rule and compass and then cut. Cutting two or three feet of strap to obtain one foot causes waste. If an odd shaped patch or pocket is required, a paper pattern should be prepared and placed on the piece of leather required. Cutting a large piece to obtain a small piece to be shaped from it is very wasteful.

Riveting.—The hole for rivet should be small, requiring the rivet to be driven, the washer should be tight, the rivet should be cut fairly close to give just the spread of metal necessary for security, the set should be used to give a good finish. If the hole is large the rivet will be likely to bend ; a bent rivet causes the head to prematurely break.

Stretching of Leather.—It should be noted that all new leather subject to strain elongates from $\frac{1}{2}$-in. to 1-in. in 12-in., according to width and substance, and whether it is subject to strain when wet from sweat or rain.

Bit-heads, throat lashes, breastplates, girths, and surcingles will stretch to the maximum.

Punching.—In punching straps the correct size of punch should be used, so that holes similar to those already in the straps may be made. When it can be done without spoiling the appearance of the strap by punching too near the point, a spare hole or more should be punched above or below that in use.

All harness and saddlery articles are punched with oval punches ; a round one weakens the strap without a smaller hole is made than can be easily worked.

Stretching Web.—Web for saddle seats may be strained, when a strainer is not to hand, as follows :—Nail each end of the web when wet to a board, then force something underneath the centre to stretch it as much as possible ; when dry, damp and repeat the stretching. The wedge must be left under the web until dry.

6.—CARE AND PRESERVATION OF HARNESS AND SADDLERY.

Orders for the care and preservation of Harness and Saddlery in Stores, issued from time to time in Equipment Regulations, and Regulations for Army Ordnance Services, apply to Shops also. It is the duty of the saddler to make himself well acquainted with them and to strictly carry them out.

The following instructions are most important :—

Storing articles with grease on the surface attracts dust and dirt, and causes deterioration.

Excessive use of dubbing or tallow on harness and saddlery leather discolours it, and gives it a part-worn appearance.

It may be noted that tallow is used, instead of dubbing, on girth straps attached to saddles, V-attachments, and officers' bridles and wallets, in Mobilization Stores.

The harness and saddlery should be kept perfectly dry.

Damp and draught are injurious to leather.

Sun and light discolours and deteriorates leather.

Articles are not to be kept near fires or heating apparatus or pipes.

The temperature when possible should be kept at about 60 degrees.

Officers' Saddles.—The new pattern (Mark IV) should be covered with thin paper to form a case, secured with string, each saddle being separate, when in stores. This is to prevent damage to the front of the saddle, protect the soft leather of the pannels, and save them from dirty marks by store handling, &c., and from accumulation of dust and dirt. They should be carefully and cleanly handled in the workshops.

Blankets, numnahs, numnah pannels, worsted girths, &c., are liable to moth, and require special care. They should not lie in shops in dirty corners.

Breechings when stored, if not kept flat, are to be folded in bundles, one seat inside the other, the loin straps of each being passed outside and round the three. Care is to be taken that the seat of a single breeching is not sharply bent.

Breast Collars should be kept on the curve similarly to when in use, and in bundles of three, paper being placed between each collar to prevent the steel-work blackening the leather. They are not to be hung over poles or narrow wooden bars.

Cavalry Rifle Buckets should be hung up on pegs by their straps in shops, and not to be left on the floors. In stores they should be hung up on lines or poles by their straps, and not stacked on each other, which flattens them out of shape.

Saddlers having the repair of these buckets should make a suitable block for re-shaping damaged ones. Particular care is necessary to preserve the projecting form of the mouth where stiffened by a plate.

Saddles should not be laid flat on the shelves to spread the flaps and loosen the attachments to the tree.

Saddles should not be thrown about carelessly, as the trees are liable to be broken ; the practice of piling a number of saddles on the top of one another should be avoided, and no weight should be thrown on a saddle when it is on the ground, as the arches are liable to bend.

All exposed ironwork should be kept bright except that issued black japanned. It may be cleaned with emery, bath-brick, or sand, and rubbed over with an oily cloth.

Rubber Rings when stored are kept in tins filled with French chalk, or kept in water.

New harness and saddlery under repair or conversion should not be handled with dirty hands. Each article should be in a clean condition when replaced in stores.

Marking.—If larger type than authorized is used on leather, it weakens and prematurely destroys the particular article.

Numnahs and blankets are often seen marked with from 2 to 4 inch type ; the excess of paint damages the articles, and is liable to produce sore backs.

Saddle seats and flaps and rifle buckets which are required to be kept stiff, should only be sponged occasionally with soap.

Other leather in constant use should be softened with good soap every day and should be well dubbed every six months as follows :— The leather having first been moistened with a sponge, the dubbing (warmed if the weather is cold) is lightly rubbed in with a sponge or brush. Then after two or three days it is rubbed off the leather, which is well polished with a brush or cloth.

Soft soap should be very sparingly used, as it contains an excess of alkali, and turns leather dark.

Leather must not be washed with soda or soaked in water. Its vitality is quite destroyed by hot water. Washing the leather with soap and *lukewarm* water, quickly and without soaking, will do the least harm if the precaution is taken to apply oil, dubbing or good soap while the article is slightly damp.

Drying leather by the fire destroys its durable properties, and is strictly forbidden.

Leather parts of harness and saddlery can be kept more durable, and a bright colour retained much longer, by avoiding when possible washing in water.

Dry cleaning, by brush and rubber, will be found in many instances sufficient to remove dust and dirt. After such cleaning, a little soap or polish for articles in daily use, or dubbing for those to be stored, may be applied.

Beeswax and saddle soap, commonly used in the Service to give a polish to the grain of the leather, are not objectionable, provided good soap is used on the flesh (under) side to keep the leather mellow.

Black saddlery leather requires greater care than brown. The best blacking only should be used to give it a good appearance.

Dubbing.—The approved mixture consists of—

Tallow	about 4½ lbs.
Cod oil	1 quart.

It is used for preserving and softening leather, and is applied to harness, strapping, &c., with a brush or cloth.

It should be sparingly used.

7. SADDLERS' MATERIALS.

LEATHER.

The leather used in the Service for the repair of equipments for saddlers is as follows :—

	Approximate weight.
Backs, black, bridle†	14 lbs. each.
„ „ collar†	22 „
„ brown, bridle	14 „
„ „ collar	22 „
„ „ heavy	31 „
Basils, brown, strained }	18 lbs. per doz.
„ „ unstrained }	
Butts, hose pipe‡	24 lbs. each.
„ millband, heavy‡	26 „
„ „ light‡	18 „
Hides, bellows‡	18 „
„ brown, cloak	12 „
„ „ crop‡	26 „
„ „ „ ‡	40 „
„ buff	8½ „
„ cow, Preller's‡	20 „
„ horse, white	12 „
„ powder§	70 „
Shoulders	6 „
Pipes, trace strips, wheel	1¼ „
„ „ „ „	½ „

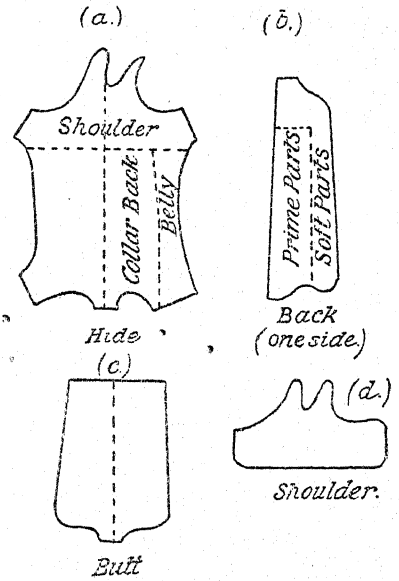
"Hide" (Fig. 142) is the term used to denote the skin of large animals, such as the ox, cow, and horse, while the word "skin" is used to denote that of small animals, such as the calf, sheep, pig, &c. (*a*).

A back is a hide divided down the middle, and from which the belly has been cut off. The two sides are often called a pair of backs (*b*).

A butt is the prime part of a hide from which the shoulder (*a*) and belly have been cut. When divided down the middle the two sides are called a pair of butts (*c*).

† Issued to Household Cavalry only.
‡ Issued to Ordnance workshops only.
§ For powder magazines.

Fig. 142.



The following briefly sets out the different methods of manufacture of the above leathers for their various uses, viz. :—

White Horse Hide.—This is prepared with alum and salt, and is known as "tawed" leather. It is used for thongs of whips.

Basils.—These are skins of sheep, tanned with oak or larch bark but uncurried.

Buff.—This hide is prepared like chamois leather. The grain is removed, and oil is forced into the fibre with heavy hammers, technically "fulling stocks." The excess of oil is afterwards washed off in a bath of potash.

Brown Crop.—This is sole leather, tanned, but not curried. The bodies of carbine buckets and lance buckets, seats and flaps of saddles, and backs of wallets are of this class of leather. It should not be softened with soap and greased like the curried leathers, but a small quantity of soap or grease may be used at intervals to preserve the grain.

Preller leather.—This leather is also known in the trade as "crown leather." It is prepared from the raw hide with salt, flour, horse grease and tallow, these ingredients being forced into the hide in revolving drums. The process takes but a few days. It is a tough leather, but stretches considerably in use. Packsaddlery, bridoon reins and thongs are of this leather.

The backs and hides not described above are tanned and curried leathers.

Tanning is a process which changes the raw hide into leather, by soaking it in dilute tannic acid, extracted from oak bark, &c.

Currying consists in softening, levelling, and stretching the tanned hides or skins which are required to be flexible ; and in saturating or "stuffing" them with oil and dubbing to make them resist water, and to give them a good appearance.

The durability and strength of this class of leather when in use depends on its being kept soft by soap and dubbing or oil.

Backs.—Heavy collar and bridle backs are of similar shape, quality, and dressing ; they vary in breadth and thickness, and consequently in weight. The substance of the leather of the articles required to be repaired must be the guide for deciding from which of the above-mentioned backs the particular part required must be cut. The butt of each back will invariably be thicker than towards the shoulder. Backs of a class will be found to vary in substance. A piece of suitable thickness may in some cases be cut either from a heavy back or collar back, or from a collar back or bridle back.

Heavy back.—This back affords about 20 lbs. of prime leather for heavy strapping to repair parts of the harness, such as breechings, breast-breechings, cruppers, hip straps, &c., and about 5 lbs. of fair quality suitable for caps of traces, or repair of neck collars, and also 4 lbs. for making ties.

Collar back.—This back is for the repair of the thinner straps, &c., of harness and saddlery. About 14 lbs. of strapping can be cut suitably for repairing bridles, head collars, all kinds of reins, neck collars, packsaddlery, &c., and about 3 lbs. of softer leather (unsuitable for straps) for caps of collars or traces, or pockets for saddle seats, &c., and 3 lbs. for ties.

Bridle back.—This is thinner than the collar back, and is intended for the repair of light parts of officers' and general service saddlery, such as bridle heads, reins, and small straps. It will give about 10 lbs. of prime, but the remainder soft parts for ties, &c.

Light hide.—This is intended for caps of traces, and forewales, afterwale, and caps of neck collars, and for parts of trace pipes, and pockets for saddle seats. It is not suitable for the repair of head collars, or for such like strapping. A few numnah straps and head collar billets may be cut from the prime parts. A hide will afford 4 lbs. of soft leather, which is only suitable for ties.

Cloak hide.—This is the grain or outside portion of a split hide. It is the most costly leather issued. The prime parts are intended for the fronts and covers of wallets, and for the lining of the new pattern A.S.C. breast collar. Only the roundings should be used for ties, viz.:—the outside parts. A hide will give about 10 lbs., suitable for repairs of the above character, and 2 lbs. of roundings for ties. The 10 lbs. of leather will make a large number of wallet covers and wallet fronts, and gussets.

Shoulder.—This is to furnish additional material for caps and

afterwales of neck collars ; parts may be used for patches of shoe-cases, &c., and the inferior parts—about one-third—for ties.

It should be noted that the soft parts of each class of back, as well as those of light hides and shoulders, afford material for neck collars (all but straps), loops, all kinds of safes, and patches of numnahs, &c. Parts unsuitable for this class of repairs will work up into ties.

Basils.—The unstrained are for re-lining neck collars and pads. The strained are for the repair of backs and welts of hair pannels ; but the unstrained can be used in place of strained, when absolutely necessary, by wetting and straining them.

Leather Ties.—No leather is issued specially for ties. They must be made from parts of all classes of leather issued, which may be unsuitable for other purposes. Cuttings from heavy backs or thick parts require reducing to a suitable substance with the spokeshave. Most of the cuttings will require wetting and slicking out before shaping. When prepared, the material will produce as follows :—

100	trace ties	from 1 lb. of	cloak hide, light hide, or shoulder.
60	„	„	collar back.
50	„	„	heavy back.

Canvas.

The canvas used in the Service is of pure hemp thread free from any mixture of cotton, and even in texture.

40-*in.* canvas is bleached, and is very stout. It is used for cartridge cartouches, loin covers, and by R.E. siege train.

36-*in.* bleached is used similarly to the 40-in.

36-*in.* unbleached (brown) is not so stout as 40-in. It is used for lining cartridge cases made of Clarkson's material.

30-*in.* is used for covering pontoons.

Hessian, packing.—Is 47, 45, 40, 36, 32, 28 in. wide, is of a light description, and is used for common purposes, and with Clarkson's material.

Sail, Canvas.—This is 24 in. wide and is numbered from 1 to 8. No. 2 is used for wagon and cart covers.

Duck.—Russian duck is of much closer and finer texture than canvas, and is superior in quality. It is used for lining covers of ambulance wagons and carts, hoods and aprons of litters, and pannels of packsaddles.

27-*in.*—This is made of both cotton and linen, and is used for tents.

Serge.

White serge is double-milled, made of pure new wool. It is 40 in. wide, and weighs 15 ozs. per yard.

Collar Cloth.

The remarks on serge equally apply to collar cloth, except that it is 60 in. wide and weighs 25¾ ozs. per yard. Used for lining packsaddlery pannels.

WEB.

Hemp.—2-in. is used for horse brushes, and 1¾-in. for curry-combs; 1¾-in. is used for trays of Pharmacy wagons.

Jute.—2-in. is used for general repairs of tents.

Linen.—1¾-in. is used for slings of inner marquee roof and repairs.

Straining.—3-in. is used for saddle seats.

COW HAIR.

This should be dry, clean, and free from lime and fleshings. It is used for stuffing O.P. drivers' and luggage saddles.

HORSE HAIR.

This is short, pure horse hair, free from any mixture of fibre, and is used for stuffing pannels of certain saddles.

FLOCK.

White flock is used for a thin padding over the straw of neck collars.

THREAD.

Black { 3-cord, coarse.
2-cord.

Flax { coarse, fine, white } used for waxed thread.

Whited brown for facings of pannels, &c.

TWINE.

Baling, 3-thread, in ½-lb. balls.
Choking, 5- and 3-thread.
Packing, large middling, and small.
Quilting pannels, in ½-lb. balls.
Sail, sewing, plain.

CORD.

Cotton, 44 yards, 1 lb., used for loops on handles of drivers' whips.
Whip, accounted for by weight.

BLACK WAX.

Is made in the following proportions of Pitch 3 lbs., Resin ¼ lb., Tallow ¼ lb.

It is issued in 2, 3 and 4-lb. tins for repair of harness and saddlery. Ozokerit is not suitable.

WIRE ROPE.

The rope is made of wire drawn from the best homogeneous steel, and galvanized or electro-plated with zinc. It has a hempen rope heart or core, and each strand has a jute rope heart or core. The cores are saturated with pine oil and tallow.

NICKEL.

Nickel buckles, &c., consist of the following alloy :—

Nickel	25	parts.
Zinc	25	,,
Copper...	50	,,
Total ...	100	,,

PASTE.

To ¼-lb. flour, well mixed in cold water, add a little resin, and boil slowly. It can be made more adhesive by adding a little glue water.

VARNISH.

Varnish for woodwork of saddletrees is made of best orange shellac, 15 oz., methylated spirits, 1 pint.

CANVAS COVERS, APRONS, &c.

The straps and chapes will occasionally require cleaning and dubbing, but they need not be cut off for this purpose ; they may also become loose, and require sewing on afresh.

Canvas covers are very frequently torn and are repaired according to the nature of the damage ; if it is a simple rent in a place where there is not much strain upon it, it may be sewn together ; but if it is near the edges, straps or lashing, a new piece should be sewn under the rent and the edges of the rent neatly sewn down. If a piece is torn out a new piece should be sewn under, and the edges of the old should be turned under and neatly sewn down.

For Saddlers' Tools, *see* pages 177–181.

SECTION V.

INSTRUCTION FOR R.G.A. SMITHS.

The Boiler.

The stoker must make himself familiar with the construction and fittings of the boiler or boilers under his charge, and carefully note that any automatic apparatus, so called, he may have charge of, is working satisfactorily.

Plate I. shows a "Lancashire" type, but the fittings on it are similar to those on most boilers, although they may vary in form, "A," the boiler, is a cylindrical shell with flat ends, the latter being riveted to the flanged ends of the former and strengthened by gusset stays, of which there are six at back and seven at front of boiler, the centre gusset at each end is deeper than the others while those on either side of it are longer, and connectod with the second section of shell (see sectional elevation between safety and dead-weight valves), by which arrangement it will be seen the longitudinal expansion and contraction is borne by two sections of the shell at each end. "B" is the furnace tube, with its ten lengths, each consisting of a welded tube, flanged, with a radius at root of flange, the whole riveted together, and acting as a longitudinal stay between the front and back of boiler, the diminishing or conical length acts as an intensifier for the draught and also allows of a length, smaller in diameter, being used, so that the distance between its outside and the inside of boiler shell is greater than would be the case if it were of the same diameter as the larger tubes, thereby diminishing the tendency to tear away the back plate from the shell when extreme expansion takes place. Between each joint of furnace tube there is a ring plate, securely riveted, and caulked between the flanges, as shown in the sectional elevation, the inner edges of ring plate provide a means of caulking inside the tube ; on the outside the edge of each flange is caulked against the face of ring plate (which is $\frac{3}{4}$ in. larger in diameter than the flanges), this form of joint is a very good one ; the radius at root of each flange allows of a fair amount of expansion and contraction, and as the flange and rivets are surrounded by water, the heated gases from the furnace cannot attack them. The "Galloway's" tubes induce a circulation of water from the bottom of boiler, but also affect the draught. The bridge "D" is of fire bricks, it seals the end of ash pit, prevents the fire being pushed into the furnace tube, and also causes the heated gases to strike the crown of the furnace tube ; the top of the bridge should be 9 in. (a brick on end)

from the inside of tube. The furnace bars are supported by front, centre, and back bearers, the rocking lever "G" causes every alternate bar to move, which breaks the clinkers that form in the furnace, and clears the space between the bars of small cinders, which would prevent the free supply of air to the furnace.

On taking charge of a boiler that has previously been in use, unless its condition is known to be satisfactory, it should be examined to ascertain its fitness for work ; the following instructions should be observed :—Remove manhole and mudhole doors. If there is another boiler working and connected with the same steam pipe, secure the hand wheel of main stop valve with a chain and padlock, take a light hammer, and a small file, enter manhole and examine all rivets and seams, feed pipes and scum troughs, clearing the holes in each, and also those of water gauge cocks, test cocks and pipes connecting steam pressure gauge ; test fusible plug, *both ends of which should always be kept clear of any deposit*, the passages to alarm lever, and dead-weight safety valves, and boiler cleaner. While it is very important that all internal parts should be examined, special attention should be given to crown of furnace tubes, also their sides in line with the fire bars, where scale is apt to form, the front and back plates (above and below furnace tubes) between the gusset stays and flanges of furnace tubes, where the gusset stays hold the plate rigid at one end, but the expansion of furnace tube at the other tends to fracture the surface of the plate, which afterwards becomes affected by the action of the water, and ultimately ends in the plate being condemned ; a similar action occurs between flange of furnace tube and shell of boiler, While examining underneath the furnace tube, attention should be given to back end of boiler, where the gusset stays impede free circulation, and mud collects, thereby causing corrosion ; the plate, however, surrounding the opening leading to the blow-off cock "N" will sometimes be found to need removing; a collection of mud having formed there, corrosion will take place. The examination should be continued on the outside, when the alarm valves, safety and dead-weight valves should be tested also, the feed valves, water gauge cocks, test cock, scum cock, blow-off cock, and that of the pipe connecting steam gauge. When it is found that all parts are correct, all dirt, cotton waste, or anything that may have collected should be very carefully removed and the doors rejointed, if steam is to be raised. If a boiler is not required for use for a long period, it should be either *filled* with water or *entirely* empty.

Before lighting fires, see that sufficient water is in the boiler, and be sure that the cocks at top and bottom of gauge are open and clear.

After fires are lighted, and until steam is obtained, allow all air to pass out at safety valve or by test cocks if such exist.

Raise steam slowly so that all brickwork may become gradually heated, thereby preventing any undue strain being thrown upon any part of the boiler.

All steam cocks when hot should be *opened and closed by degrees before leaving them quite open*; this will allow the metal surrounding the plug to expand evenly, and the latter to be turned freely when required to "shut off."

Steam valves should never be opened suddenly, as the sudden liberation of steam will sometimes cause priming in the boiler, when the surface of the water is swept by the steam on to the cylinder, where, if escape valves are not fitted, accidents may happen.

If possible, do not blow off a boiler to empty it when it is hot, for the following reasons:—1st. Parts of the boiler where there is brickwork (as the bridge, for instance), will take *longer* to cool than others, and strain the boiler. 2nd. Mud and other sediment that would remain in a soft state if the boiler is cooled slowly will, if the boiler is "blown out" when hot, become baked, and adhere so firmly to the interior as to require a chipping hammer to remove it. A safe method, if time admits, is to draw the fires, close furnace and ash pit doors, also dampers, and after 24 hours remove manhole door; fill the boiler with water by a hose or other means, and afterwards, while the water continues running in, open blow-off cock; this will allow all parts to cool uniformly; when sufficiently cool, cease running water in, and run all water out by blow-off cock. When the water is sufficiently low to enter the boiler, a wood scraper and a stiff brush may be used to remove the mud, &c., adhering to the sides and other parts of boiler and fittings; all parts where possible should be treated in this way. Those parts where scale has collected will require a scaling hammer to remove the very hard deposit. When there is hard deposit to remove, the opening to blow-off cock should be plugged to prevent the dirt clogging the blow-off cock.

As scale and soot are bad conductors of heat, all heating surfaces should be kept clean; this applies to those parts dealt with above as well as the insides of furnace tubes, and shell of boiler in flues (as in the case of a Lancashire or Cornish boiler), and to the tubes of portable or locomotive boilers; these latter should be cleaned every day.

To put in a new set of fire bars, fill the space, and remove one bar to allow for expansion.

Safety Valves should be tried once or twice every day (being careful not to open them suddenly) to see that they act freely.

Gauge Cocks and water gauge cocks must be tested frequently throughout the day to ascertain that they register correctly.

Pressure Gauge.—The pointer should be at zero when the boiler is cold, but when the safety valve is blowing off, the gauge should show a corresponding pressure. If the safety valve and steam gauge do not agree, the latter should be tested by one known to be correct. In testing a boiler by water pressure, use another gauge, and shut off the connection with the steam gauge, as it is found that water pressure distorts the tube of a steam gauge.

The *feed pumps* should be carefully examined as often as possible, so that the condition of the valves may be known; they should be kept perfectly clean. If possible, feed the boiler steadily throughout the day; this will aid circulation in the boiler, and lessen consumption of fuel and labour of stoker.

Valves.—The action may be ascertained by placing one end of something metallic, a steel rule for instance, between the teeth, resting the other over the valve, and closing both ears, when the clean cut-off, or leaking part, will be readily detected.

Precaution.

A careful stoker will endeavour to keep the water level and steam pressure uniform throughout the day. Should the water from any cause become low, smother the fires at once, with any ashes, or earth that can be obtained most readily; if coal only is available, use it freely, and draw the fires when such can be done without increasing the heat, and allow furnace doors to remain open; close the dampers and push weight of safety valve towards the centre to allow the steam to escape freely. *Do not turn on the feed, or stop the engine, until the fires are out and the boiler cooled down sufficiently. If, however, the boiler is connected with other boilers, the main stop valve must be closed.*

Cold feed.—Cold water should not be used if warm is possible; it is usual where a "heater" is not used, to lead the feed pipe through the water surrounding the furnace, before its openings discharge the water into the boiler, and then, by fine streams towards the coolest part of the latter. Cold water must never be pumped into a hot boiler.

Firing.—All large pieces of coal should be broken, for if used when heated they burst and their gases pass away largely unconsumed, pieces about 2 in. are best to use; these should be thrown on evenly, and regularly, a little at a time; where the draught is bad, a thin fire will be best, the grates must be evenly covered and no air holes allowed; a moderately thick and hot fire, with plenty of draught, will give the best results. The fire should not be cleaned oftener than is necessary. The furnace door should not be kept open more than is actually required. Use the rake as little as possible.

It is important that no water should come in contact with seatings or coatings of boilers, also that no air enters the flues except through the fire. Any leaks in the boiler should be brought to notice of the armament artificer i/c and repaired as early as possible.

If it is necessary to use muddy or salt feed water, a portion should be blown off frequently, according to the condition of the water. It will also be necessary to empty, clean, and refill the boiler every week. The scum cock should be used freely, to get rid of the impurities floating on the surface of the water. When using the blow-off cock, it should not be left, under any circumstances, until it is shut off again.

The Steam Engine. (Plate II.)

The driver must make himself thoroughly familiar with the construction and every part of the engine, or engines, which he has to work ; nothing should be considered unimportant.

Before starting an engine, its fitness for work should be ascertained by a careful examination of all its parts. If its condition is uncertain, the steam chest and cylinder covers should be removed, when slide valve, and the bore of cylinder, packing rings, and springs of piston can be seen, and if necessary the latter can be withdrawn, which will give access to the front end of the cylinder, when all grease can be removed and steam ports cleared. Should the bore of the cylinder, the packing rings, or the faces of slide valves be scored or much worn, such should be reported. All grease and dirt must be removed from the steam chest, and if found correct, each part should be thoroughly cleaned and oiled before it is replaced. In the case of expansion gear with variable cut-off, if the plates are removed for any reason the valves should be re-set by a competent artificer.

Great care must be exercised in replacing the piston, adjusting the packing rings, springs, and the junk ring, so that no parts are burred, or any gritty matter left either in the cylinder or the steam chest.

The joints of the covers should be securely made to ensure accuracy. No extra force should be applied to the doors ; they should be pushed into their position, great care being taken that the space between the faces of the joints is equal all round. When this is so, screw on the nuts until each touches the cover, then with the spanner screw up each nut half a turn at a time one after the other in regular order, repeating the operation until the joint is securely made.

Attention should be given and the necessary adjustments made to the following :—

(*a.*) The packing glands of piston rod "C," tail rod "D," slide rod "H," throttle valves, main stop valve, feed pump, circulating pump, and air pump. Decayed packing should be replaced by new.

(*b.*) All nuts and screw bolts, keys, cotters and drain cocks of cylinders should be tested and adjusted if required.

(*c.*) The guides of piston and tail rods are liable to become scored ; this should be reported.

(*d.*) The brasses in connecting-rod ends, bearings of crank shaft, and parts of governor should have attention, and all necessary adjustments made.

(*e.*) Carefully examine all lubricators, and see that all worsteds and caps are clean. Should the worsted be sticky, it will not supply the bearings with oil, and new material should be added. Worsteds

should be placed in the feeding tubes before starting, and removed when stopping the engine. All oil-holes should be thoroughly cleaned. After any adjustments have been made to the connecting rod or piston, the cylinder clearances should be checked and if found to be unequal, steps should be taken to equalise them.

NOTE.—No emery paper or gritty substances should be used in cleaning any working surfaces of engines or machinery.

When all adjustments have been made, the engine should be turned by hand, and the action of each part carefully noted. Under no circumstances should steam be applied if the condition of any part is at all doubtful; leave the crank in the proper position for starting.

Warming the Cylinder.

Under no circumstances should steam be turned fully on into a cold cylinder, or the uneven expansion will probably crack the casting. Open the drain cocks fully, and the main steam valve slightly, so that the cylinder may become warm gradually. The stop valve must not be opened while steam is being raised in the boiler. The fly-wheel should be turned by handspike (or bar) to alter the position of the piston in the cylinder (taking care, however, not to allow it to stand so that the slide valve will cover both admission ports), in order that the steam may pass on to the other side of the piston, and that end of the cylinder becomes warm also.

If it is a condensing engine, then as soon as there is steam enough to start, about two revolutions should be made to exhaust the condenser, with the injection cock closed, then open the injection cock fully, and after required vacuum is obtained, regulate the amount of injection, so that the required vacuum can be obtained with the least amount of injection. Should, however, there be insufficient vacuum, examine the drain cocks, escape valves, packing glands, and all parts that may admit air for the cause: or the injection may not be sufficient, when an auxiliary supply may be necessary. Should the foot valve, bucket valve, or head valve be at fault, the defect should be at once remedied; if it cannot be traced, the engine should be stopped and the matter reported. If a surface condenser, the circulating pump will cause the water to flow through the tubes, the cool surface condensing the steam, when the air pumps will exhaust the condenser.

Before starting a condensing engine, see that the surface main water valves are open, in addition to the injection or other valves in the engine house.

While "warming," all those parts which cannot be approached when the engine is working should be cleaned, and the lubricators filled and adjusted.

The engine should never be turned without signalling to the machine rooms, as accidents might happen to any men who

might be oiling shafting, or otherwise engaged among the machinery.

When all is ready with drain cocks open, see the crank is in proper position, admit steam fully, and allow the engine to run, *never allow the engine to race*, then regulate until the required speed is obtained, when it should be noted if the governor will (through the throttle valve) maintain perfect control over the engine; if not, attention should be drawn to it, but no adjustment should be attempted until it has been inspected by a competent artificer.

The driver should note the working of his engine throughout the day, frequently feeling the bearings in case the lubricators fail to give the required lubrication. It sometimes happens that lubricators worked by clock gear will choke; the gear becomes damaged, and a hot bearing is the result. It is safest to take nothing for granted, but to test every part frequently, and when the engine is stopped, which should be as soon as possible, make every necessary adjustment.

A hot bearing can generally be cooled by a strong mixture of soft soap and warm water, for the alkali cleanses while the fat lubricates the bearing, and together they carry away any gritty matter that may have collected. When the engine is stopped, the bearings should be examined and thoroughly cleaned.

A leaky slide valve will allow steam to enter the cylinder after the point of "cut off" has been reached. To ascertain if there is a leak:—Set the crank so that the slide valve covers both admission ports, block the fly-wheel in this position, open the drain cocks or those used for the indicator, and open the steam valve, when, if the valve is leaky, steam will issue; this should be reported.

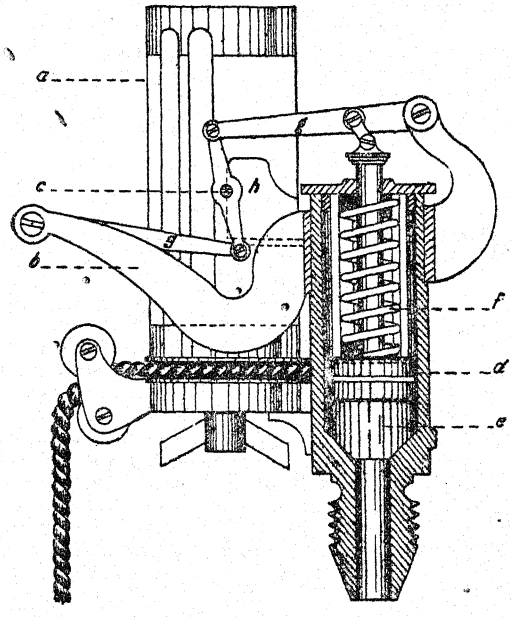
A leaky piston will allow steam to escape past and out of the cylinder without doing any work. To test the piston:—Set the crank at $\frac{1}{4}$-stroke, block the fly-wheel and open the drain cock, or that used for the indicator on the opposite end of the cylinder; then turn on steam, when the latter will show if the piston is leaking. Tho slide valve must first be correct or the result will be misleading.

Knocking sounds may be due to one of the following causes:—Play in the bearings of the crank shaft; the connecting-rod ends; the piston loose on its rod; or water in the cylinder. If any knocks occur, the drain cocks should be open, and if the knocking does not cease, a careful examination in detail will discover the true cause, when the required adjustment should be made.

The driver should keep all engines and machinery under his care perfectly clean. If possible, he should never sweep the house when the engine is working, nor allow an engine not in use to stand long in any one position. On stopping the engine for the day, open the drain cocks, shut injection and other valves, remove all worsteds from the lubricators, place all spanners in their rack and all tools in their proper places.

The Steam Engine Indicator.

Fig. 143.



a. Drum or paper cylinder.
b. Arm supporting parallel motion.
c. Pencil or brass points for describing diagram.
d. Piston showing water packing ring.
e. Cylinder truly parallel in which piston travels.
f. Spiral spring.
g. Levers and link of parallel motion.
h. Diagram partly drawn.

Fig. 143 shows an indicator of the Richards' type ; by its aid is ascertained (*a*) the power developed in the cylinder ; (*b*) the accuracy or otherwise of the slide valve, and (*c*) whether there is any leakage of slide valve or piston.

The area of piston *d* is $\frac{1}{2}$ a square inch ; it is permitted to leak a little, which renders its action almost frictionless and does not affect the pressure on either side of it for leakage ; unless it be sufficient to add to the atmospheric pressure above the piston, cannot effect the accuracy of the indicator.

The motion of the piston *d* is $\frac{2}{3}\frac{5}{2}$ of an in., and the travel of the pencil *c* is $3\frac{1}{8}$ in. The paper cylinder *a* is 2 in. diameter, and

length of diagram h a possible $5\frac{1}{4}$ in.; the best length, however, is $4\frac{1}{2}$ in. The diagram is drawn by a piece of pointed brass wire on metallic paper.

The principal features of the instrument are: a short and strong spring f, a short motion of piston d, light reciprocating parts, considerable area of cylinder e, an arrangement of levers g and a parallel motion for multiplying the travel of the piston d in such a manner that the diagram is described in the usual way and of the ordinary size. The proportion between the motion of the piston d and that of the piston c is 1 to 4.

The springs have a brass nut on each end, on one of which is marked the limit of pressure thus, $\frac{47}{15}$ = 47 lb. steam, 15 lb. (or 30 in.) of vacuum; on the other nut is the scale strength of the spring; thus if a $\frac{1}{16}$ spring is used, a $\frac{1}{16}$ in. up or down on the diagram represents 1 lb. pressure; if a $\frac{1}{20}$ spring, then $\frac{1}{20}$ in. = 1 lb. pressure, and so on.

The indicator must be kept perfectly clean and carefully lubricated in all its working parts. When adjusted for taking a diagram, the "paper cylinder" must work freely between the stops, but not touching either. After use it must be carefully cleaned before replacing in the box.

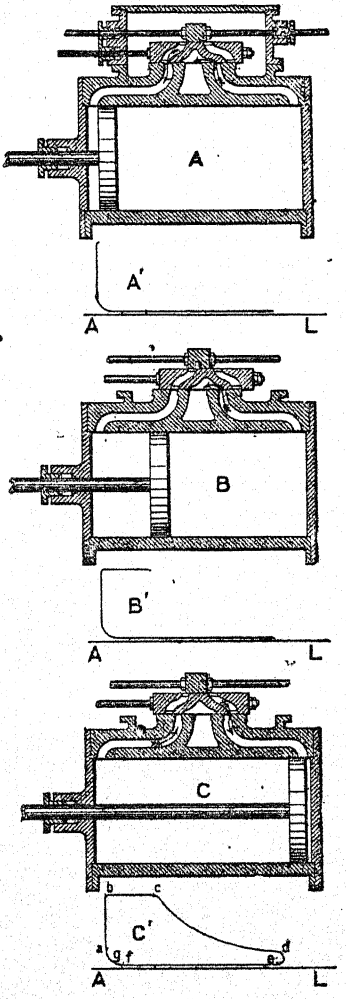
A, B, C, and A^1, B^1, C^1 (Fig. 144) show how the diagram is obtained in a non-condensing engine. "A" shows the piston in cylinder just commencing its backward stroke, the expansion valve is open (*see* also "ordinary fixed cut off" steam engine details, Plate II); there is a passage for steam through slide valve, and admission port to piston, and as the steam pressure also acts upon the piston of the indicator, the pencil rises, the vertical line is drawn and a small portion of "steam line." "B" shows the expansion valve has covered the port in slide valve so that no more steam is admitted, but, as up to this point the steam pressure has been constant, the "steam line" has been drawn by indicator parallel with atmospheric line A L. Steam now being cut off, it will be seen that there is slight curve (the "point of the cut off"), so that from this point the steam increases in volume but decreases in pressure, as will be seen by the diagram C^1, which shows a steady fall, till the "point of release" is reached, when the slide valve opens (*see* C), exhaust takes place, when on the return stroke, the "line of back pressure," "points of compression," and "cushion" are reached, and the diagram completed.

The indicated power of an engine is obtained by multiplying the mean pressure per square inch acting upon the piston throughout its stroke, by the area of the piston in square inches, and the speed of the piston in feet per minute.

The usual rule observed is when P = mean effective pressure in lbs. per square inch, L = length of stroke in feet, A = area of piston in square inches, and N = the number of strokes per minute, then

$$\frac{P.L.A.N.}{33000} = H.P.$$

Fig. 144.



The points in C[1] are as follows—

a, point of admission.
a to *b*, admission line.
b to *c*, steam line.
c, point of cut off.
c to *d*, expansion curve
d, point of release.
d to *e*, exhaust.
e to *f*, line of back pressure.
f, point of compression.
g, point of cushion.

Hydraulic Machinery.

Hydraulic power is used for loading, elevating, and traversing heavy guns, and also for ammunition lifts, cranes, &c.

The power is supplied by pumps worked by steam, gas, or oil engines.

The pumps are of the *direct* or the *differential* types. The direct plunger sends the whole of the water drawn into the pump chamber on to the accumulator in one stroke, while in the differential pump the liquid drawn through the inlet valve is passed on to the accumulator in forward and a backward stroke.

The accumulator consists of a vertical cylinder fixed into a base plate, with a plunger working in it, on the top of which is suspended by a cross head a weighted tank, or for confined positions weights cast to suit the space they are to occupy. A packing gland in top of ram cylinder prevents the escape of water there.

The accumulator is connected at the bottom with the pumps on the one hand and with the machines to be driven on the other hand.

On starting the pumps, the water fills the pipes of the service main, including the connection with the accumulator; and the engines continuing to work, a pressure is obtained which forces the weighted ram upwards. In this condition the latter (as "fluids transmit pressure equally in every direction") exerts throughout the service main a pressure equal to that on each square inch within the ram-chamber of the accumulator, and which, if a valve is opened to any machine in connection with the pressure main, will cause the same to work.

When the pressure pumps supply more water than is required for the machinery, the ram will rise towards the top of the cylinder, and a chain acting through a train of pulleys will close the throttle valve and regulate the admission of steam to the engine. On the accumulator descending, the valve is opened by the chain, and in this way the engine and pumps are controlled automatically.

But should the pumps be in full action, and the whole of the work be "taken off" the pressure main when the accumulator is near the top, an escape valve is provided, which is opened by a chain or rod connection to allow the surplus water to pass away until the throttle valve resumes control of the engine.

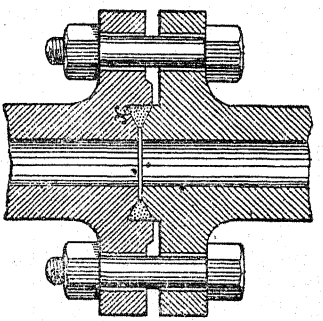
To provide against an accident, such as a pressure pipe bursting, a safety valve is provided, which will allow water to pass freely into and out of the accumulator when the pressure is equal throughout the main. On a pipe bursting, the weighted tank would descend violently, but this valve rises against its seating, the water under the accumulator passes through very small holes in the valve, and in this way the weight descends slowly to its stops.

When the accumulator is working properly, the ram is in equilibrium, rising and descending according to the demands on the pressure main.

Air cocks are usually provided in the highest part of the service; these should be opened occasionally to ensure the pipes being filled with water

Each stroke of the pump on commencing work removes some of the air from the feed pipe and expels it by the delivery pipe, when the water will flow by atmospheric pressure into the pump, and so a continuous supply is maintained. It is evident that the feed or suction pipe should be perfectly air tight in all its joints, or the action of the pump will be impaired.

Fig. 145.



Pipes of pressure mains are either cast iron or weldless steel. The joints are flanged as shown in Fig. 145. Copper pipes are often used where small diameters of pipe are required.

To bend a copper pipe it is usual to fill it with lead or resin to avoid "kinking it," and after the required shape is obtained, if the pipe is carefully heated, the lead or resin will run out.

Packings.

(*See also* Regulations for Magazines and Care and Preservation of War Material.)

The packings used for stuffing boxes are :—

1. Hydraulic packing ; viz., plaited cotton round a core of india-rubber soaked in tallow.

Leathers that have become hard may be softened by soaking in warm water and rubbing well without dubbing until pliable.

All working parts must be kept thoroughly clean and lubricated ; attention on this point should be given to packing glands and joints of feed pipes ; also to those of pressure main.

Care should be taken that the accumulator will, on rising to the top, adjust the throttle valve, and so control the admission of steam to the engine ; also that the connection with the escape valve is in proper adjustment.

Leather Packings.—When inserting these, great care is necessary in order that the edges may not be damaged.

Feed Supply.

Water tanks should be kept clean and covered to prevent dust and gritty matter entering the suction pipe and cutting the valve faces. If possible, the end of this pipe should have a copper gauze nozzle.

Service liquid.

That used *in summer* is a mixture of 50 lbs. of soap to 1,000 gallons of water, and *in winter* a mixture of one part of glycerine to two of water. Both the mixtures assist to lubricate the working parts and keep the packings and leather supple. The glycerine is to prevent the liquid freezing in the pipes.

Burst pipes.

Should a pipe burst, the stop valves must be closed to prevent the works being flooded.

Leaks.

To ascertain if there are any leaks in the pressure main, pump up the accumulator to its extreme height, close the stop valve on the pump side, and mark the position of the accumulator, when the distance dropped in a given time will show the amount of leakage at glands, valves, or joints.

GAS AND OIL ENGINES.

As both gas and oil engines are now used in the service, the machinery gunner will be able to remedy most defects in connection with them by attention to the following notes and directions. He should always carefully read the working instructions prepared by the makers of the different types of engines. A card of instructions is as a rule sent with each engine.

In most types the "Otto" cycle of operations is adopted, which is as follows :—

1*st Revolution.*—First *outgoing* stroke of the piston, the gas and air valves open at the beginning of the stroke, when the explosive charge is drawn into the cylinder.

First *incoming* stroke of the piston (the valves being closed) the mixture of gas and air is compressed.

2*nd Revolution.*—Second *outgoing* stroke of the piston (at its commencement), the "ignition valve" opens, when a communication is made between the cylinder and the inside of "ignition tube," an explosion takes place, and the piston is forced forward, the charge expanding for $\frac{9}{10}$ of stroke, when the exhaust valve opens.

Second *incoming* stroke.—The production of combustions are swept out of the cylinder by the piston through the exhaust valve.

It will been seen there is only one explosion in four strokes of the piston, or during two complete revolutions, hence the need of the momentum of a fly-wheel to continue the other three strokes.

The valves are worked by a second motion shaft driven through mitre toothed wheels (or other gear) by the crank shaft, but making

one revolution only to two of the latter. This shaft is not always the exact adjustment with the crank shaft, and consequently the valves will not act correctly. (*See* Description of Cycle.)

Should the engine refuse to start it can be turned by hand and—

1st. The valves examined to see that they act at their proper times throughout the cycle.

2nd. The "ignition valve" may not open at the proper time, or sufficiently to allow the explosive mixture to be forced into the ignition tube and so communicate with the charge in the cylinder before the valves close.

3rd. The "ignition tube" may not be hot enough to explode the mixture, or it may have become foul inside.

4th. The valves may be choked with greasy soot.

To rectify these faults proceed as follows :—

1st. If the valves do not open correctly the gearing of counter-shaft in the crank shaft will probably be at fault, and must be correctly adjusted.

2nd. If this valve is at fault it must be made to act properly.

3rd. The tube should be removed and examined, and if furred inside replaced by another. (It should be remembered that the explosive mixture requires to be forced sufficiently high in the ignition tube to reach its bright red-hot portion to ensure an explosion.) If the makers' supply of tubes become exhausted, it is very important in making a new one that it is the same diameter and length as the old one, so that it will contain the same volume of gas, in order to ensure correct time of ignition.

4th. This soot should be thoroughly cleaned off valves, &c., as in addition to fouling the valves it may pass into the cylinder, where it becomes caked about the piston rings, which will set fast and so allow leakage.

A partly inflated gas bag suggests that the engine is using more gas than the supply pipe or meter can supply at the required working pressure.

Explosions in the exhaust pipes are sometimes caused by (*a*) a leaky exhaust valve allowing part of the charge to escape which collects and is exploded by the flame of a later explosion, or (*b*) when the engine is regulated by the governor gradually diminishing the gas supply, when the mixture becomes so weak that it does not readily ignite, because of an unexplosive portion of the charge having been compressed into the ignition tube and miss-fires happen. The accumulation of this gas in the exhaust pipe may be ignited by a flame from a later charge, when a serious explosion may occur.

Electric igniters are liable to become foul from deposit, and cease to spark ; these points should be cleaned occasionally. Sometimes the presence of air in the gas pipe will cause a failure. By opening some connection or an ordinary gas cock, the gas may be tested, and air, if present, allowed to pass off.

Water jacket.—In order that lubrication may be possible in the cylinder, where the explosion generates great heat suddenly, it is surrounded by a jacket in which water is circulated freely (if

possible this should be rain or condensed water). The water should enter underneath the cylinder of a horizontal engine, and at the bottom of the cylinder in vertical types, passing off at the top or the opposite side in each case. The engine should never be worked unless the water jacket is full and in connection with a large water tank, to keep the circulation constant. If the cylinder becomes much hotter than the water tank, there is an obstruction in the circulating system which must be sought out and removed.

If the engine is likely to be exposed to a frost while not working, the cylinder should be kept warm while the frost lasts, or else the water run off to prevent the cylinder being ruined by the water expanding when freezing.

The driver should never attempt to turn the fly-wheel by placing his feet on it, as an accidental start in the wrong direction may throw him off, nor should he ever attempt to pass through a belt when running, or a serious accident may result.

Oil Engines.

Most of the remarks on the "gas engine" apply also to oil engines.

In the oil engine a heavy petroleum oil is pumped into a red-hot vaporiser, converted into a gaseous condition and mixed with the required volume of atmospheric air for its combustion, and afterwards exploded by some method of ignition.

There are several types of vaporisers in the service, which may, however, be described as—

1st. A separate vaporiser into which oil and *all* the air required for its combustion are pumped into the cylinder and ignited by electricity.

2nd. The oil and *some* of the air required for combustion is pumped into a vaporiser and the remainder of the air passes into the cylinder through a heated tube and a separate valve.

3rd. Oil is allowed to drop by a separate passage on to the seating of an air supply valve and passes with the whole volume of air into the cylinder.

4th. Oil is pumped into the vaporiser, and the whole volume of air required for its combustion drawn through the air admission valve into the cylinder. In this latter type the "cycle" is the same as that described for gas engines. On the first outgoing stroke of piston, air is drawn through a valve opened by a lever worked by a cam which also works a small oil feed pump, so that, while air is entering the cylinder, a spray of oil is pumped into the vaporiser, where it is "vaporised," or converted into the gaseous condition. On first incoming stroke, the air and vapour mingle, and are compressed until the end of the stroke, when the mixture is ignited by the red-hot vaporiser, and the force generated by the explosion impels the piston on its second outgoing stroke (or working stroke). On the second incoming stroke the exhaust valve is opened by means of another cam and lever, and the products of combustion swept through the valve and exhaust pipe into the atmosphere.

Care must be taken that the vaporiser is hot enough to turn the oil into vapour; no attempt should be made to start the engine until this is the case, as unvaporised oil will be carried into the cylinder and make starting difficult.

Oil Feed Pump.—The pipe connecting pump with vaporiser must be free from bends in which air may collect, or the latter will cause the oil pumped to dribble instead of spurting into vaporiser. If the spray nozzle in the latter becomes foul, it also will delay delivery and cause miss-fires.

Feed Nozzle.—This should be kept clean and always covered with oil in the tank, or the pump will draw air with the oil.

Overflow Valve.—This valve will show if the "governor" is acting, and the pump working satisfactory.

Lubricators.—These should be carefully examined, fed, and all bearings and working parts oiled, so that as soon as the vaporiser is hot enough the engine may be started, or the lamp will be required a second time.

Governors may be made to control the engine by working to the maker's instructions and watching the effect of any alterations made.

Jointing Vaporiser.—When sheet asbestos is used it should be painted both sides with wet blacklead, and after the vaporiser is warmed the nuts of bolts should be carefully screwed up, or the joint may "blow," during compression stroke.

Caution.—A light should never be used for any internal passages until the engine has been turned several times with the covers off to make sure that no gas remains, otherwise an accident may happen.

The Piston.—This should be removed periodically and thoroughly cleaned, care will be required in withdrawing it, that it does not strike the cast-iron frame, and also that the piston rings are replaced in exactly their former position. A hard wood scraper and a little oil will remove hard accumulation from the piston, cylinder, or the passages.

The Silencer or Muffler.—This should always have a few inches of water to deaden the sound, but as water will collect, due to condensation, provision should be made for drawing off this to the proper level. The connection from the "silencer" should be larger than the exhaust pipe and as high as possible; sometimes these pipes are carried to a height of from 50 to 60 feet.

NOTE.—The exhaust should not be led into a brick chimney, as it is found to cause damage therein.

Full Load.—An engine should work at its best when driving a full load and under perfect control of the governor.

Light Load.—When there is to be a run of light work, the oil feed should be adjusted so that the governor does not "cut out" the supply of oil to vaporiser. It will be necessary to partly close the water supply cock to limit the circulation round the cylinder and vaporiser jackets, where the latter exist, so as to keep them warm, or miss-fires and irregular explosions may occur.

Choked Parts.—The parts likely to become choked are the air valve, piston rings, oil feed valve, pump connections, neck of vaporiser, oil spray nozzle in combustion chamber, exhaust pipe and silencer.

Knocking in Cylinder.—This may be caused by the vaporiser becoming cooler, when an explosion is missed and the next is premature.

Miss-fires.—These may be caused by the irregular supply of oil, or by the oil dribbling into vaporiser instead of spurting, when there will not be sufficient vapour to make an explosive mixture at the proper time.

Irregular Explosions.—These may be caused by air, or exhaust valves not acting correctly, weak springs of same, or their passages becoming choked.

Excessive Explosions.—These may be caused by several miss-fires when the cylinder becomes overcharged with combustible mixture, and then exploded, variations of the load, and also failure of the governor may be the cause.

Cleaning.—All parts of the engine should be kept perfectly clean, the outside surfaces free from oil or the odour from the latter will become offensive.

Sweeping.—As the front end of the cylinder is open, the engine-house should not be swept while the engine is working. Every effort should be made to prevent any dust or grit entering the cylinder though the front end or the air valve.

If during work smoke issues with the exhaust, it shows that combustion is imperfect; the result will be a deposit of soot which will foul the piston and valves. The vaporiser should be examined, and if necessary re-heated, as it may have cooled by repeated miss-fires due to imperfect action of the governors (*see* "*Miss-fires*," above).

Leaks may sometimes be detected in gas or oil engines by turning on the compression stroke slowly, when it will be seen if the valves or joints leak, in which case there will be miss-fires and loss of power.

The usual proportions of air to gas are 8 to 10 volumes of the former to 1 volume of the latter.

Lubrication.—As fatty oils oxidise when exposed to the great heat of these engines, they should not be used, vegetable oils generally are also unsuitable. Pure mineral oils are the best for lubricating purposes.

Management of Direct Current Dynamos.

Starting.—Before starting a dynamo see that all connections are correctly and firmly made and the lubricators filled with oil and working properly, also that the brushes bear evenly on the commutator; all switches should be open so that the machine starts without load. When the machine has attained its full pressure as indicated by the voltmeter, then the circuits may be gradually switched on, taking care to move the brushes forward as the load increases.

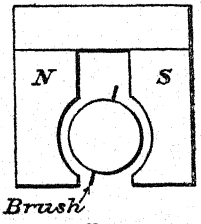
When the dynamo is direct running, *i.e.*, without accumulators, it is better to close the switches when the pressure is 75 per cent. of the full, so that the lamps light at a dull red, and gradually brighten to the normal candle power; this is a great protection to the lamps.

Stopping.—The switches should be opened one by one until the whole load has been taken off the dynamo, the engine should be slowed down until the pressure (viz., the E.M.F.) has died away, then the brushes should be raised and the engine stopped. If the brushes are raised before the pressure has died down, the insulation of the field bobbins and armature have a great strain thrown upon them which may cause them to break down to the body of the dynamo. When this is the case, the machine is practically useless until it has been repaired. The person who lifts the brushes under these conditions will get a severe shock.

Brushes and Commutator.—Brushes of continuous current dynamos have to be set at certain positions to one another, and also to the field magnets, viz.:—

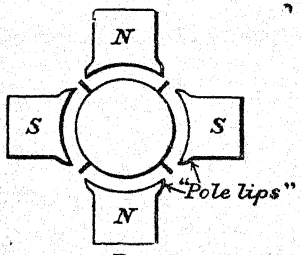
2 pole machines, exactly	$\frac{1}{2}$	of circumference of commutator.					Fig. 146.
4	"	"	$\frac{1}{4}$	"	"	"	" 147.
6	"	"	$\frac{1}{6}$	"	"	"	" 148.

Fig. 146.



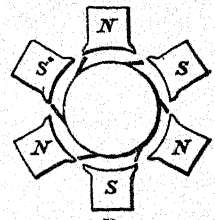
2-POLE.

Fig. 147.



4-POLE.

Fig. 148.



6-POLE.

whether in 2-, 4-, or 6-pole machines the brushes must rest on the segment which is attached to the section of the armature which lies between the "pole lips," this is when the machine has no load on it, and as the load comes on, the brushes will show signs of

sparking. This is got over by shifting the brushes a little, in the direction of rotation ; as the loads goes off the brushes are gradually put back into their original position.

The brushes on the same rocking arm should have their lips resting on the same commutator segment. The tension required is such that the brushes are held with a firm elastic pressure on the commutator. They must not bear too heavily on the commutator, or grooves will be cut in it, and these will cause sparking at the brushes. On the other hand, if they do not bear firmly enough they will jump. If there is any vibration in the machine this will also cause sparking, besides causing the commutator to wear unevenly, due to the pressure on some parts and not on others. When the dynamo is running, a little vaseline, plumbago, or oil applied to the commutator prevents it from getting too dry and scoring. This should be applied by means of a piece of rag (cotton waste should never be used) or better still by the finger.

Bearings.—These are oiled in two ways. The one most commonly used and the best for small machines is the "sight feed lubricator." With this kind, constant attention must be given that they do not run short of oil or stop feeding.

The second, and certainly the best for dynamo bearings, is the "ring oiler." This is simply one, or more rings, the top of which rests on the shaft through grooves cut in the brasses, while the bottom dips into a well of oil ; as the shaft rotates it draws the rings round with it, thus carrying up the oil. When once the oil well has been filled, care must be taken that the oil does not get too thin, and also that it does not become dirty (which is due to the wearing of the shaft and bearings). In either case the oil must be drawn off and a fresh quantity put in. Machines having this kind of lubrication will work every day for a month without requiring fresh oil.

Belting.—The greatest care must be taken that the tension is kept uniform and not too great: this is, of course, particularly necessary in the case of new belts. Whenever a dynamo has to be run by means of ropes or belt it should, if possible, be so arranged that the tight side of the belt is nearest to the ground. This gives a larger contact service between the belt and dynamo pulley and so prevents to a large extent slipping on the pulley, which causes it (the pulley) to get very hot, and also makes the lights in lamps go up and down, that is if the machine is lighting any incandescent lamps.

With due regard being paid to the foregoing remarks, there will be little or no trouble if the following items are carefully attended to :—

No. 1. Dynamo must be kept perfectly dry and clean.
„ 2. Bearings well oiled.
„ 3. Commutator kept clean and lubricated.
„ 4. Brushes well trimmed and adjusted to load.

Care of Dynamo.—The dynamo should be kept free from dust or moisture, and, when not working, closely covered by a suitable and perfectly clean cover. Sweeping and dusting should not be

allowed when the machine is working, as the magnetism of the "field magnet" will draw small metallic substances into the armature tunnel and so cause the insulation of the armature to become damaged. Nails, nuts, bolts, &c., should not be permitted to lie near the machine. Spanners and other tools should always be in their proper places when not in use. An oil can should not be used near the armature when the dynamo is working unless absolutely necessary. Copper oil cans are the best for use with dynamos.

Care of Commutator.—The commutator should be carefully examined to see whether brass or other filings may have collected and adhered to the insulation between the copper segment, in such case a short circuit would be formed, thus causing damage to the armature. Oil should not be allowed to settle on the commutator as it may penetrate the insulation, become burnt and carbonised, when sparking occurs and so cause a short circuit. The commutator always gives the best results when it has a polished surface of a dark bronze colour.

Care of Brushes.—These should be carefully examined to ascertain whether their springs and adjusting screws are in order, and whether there is any grit, dust, or metallic dust on their bearing surface. In adjusting the brushes during work, that position will be found the best that gives the brightest lights in lamps with the least sparking.

SECTION VI.

The portion of the book which has in the past dealt with care and preservation of material (Section 6) has been omitted from this issue of the Handbook of Artificers. The "Regulations for Magazines and care and preservation of War Material" is the authority on such matters.—Vide *Army Order 127, 1913.*

SECTION VIa.

TESTS FOR CANDIDATES FOR ARTIFICERS' COURSES OF INSTRUCTION (AS SMITHS, FITTERS, OR WHEELERS) AT THE ORDNANCE COLLEGE.

Any of the following tests may be selected :—

Smiths.

1. Make a pair of hollow bits to take not less than 1 inch round iron.
2. Weld two pieces of round iron, 1 inch diameter, to form a right angled joint.
3. Make a nave band, 6 inches internal diameter, from a bar of flat iron 2 inches by $\frac{1}{4}$ inch.

Fitters.

1. Square plug and socket
2. Double dovetail brazing joint } *see* Sketch.
3. Dovetail joint

Wheelers.

1. Make a mortice and tenon joint such as is used for an earbed of a wagon.
2. Connect two pieces of timber, 6 inches by 6 inches by 1 inch by common dovetailing.
3. Make a small sunk panel door 16 inches by 10 inches by 1 inch.

Directions for carrying out the Test.

1. The test being decided upon, the candidate will be given the tools and material he considers to be most suitable for doing the work. No files will be allowed in the smiths' test. He will not be advised as to the selection of either the tools or the material, and every precaution will be taken to insure that the work is done entirely by the individual who is being examined. (NOTE.—A smith will be allowed the services of a hammerman.)

2. On completion, the test job will be forwarded to the Commandant, Ordnance College, with the following certificate :—

Certified that_____was tested as a _____ in the workshops of_____ on _____

The test selected was_____

_____

_____

The candidate was given the tools and material he desired but he received no advice or assistance of any kind, and the test job now forwarded was done entirely by him.

The time taken was_____

Detail of previous experience at trade, giving—

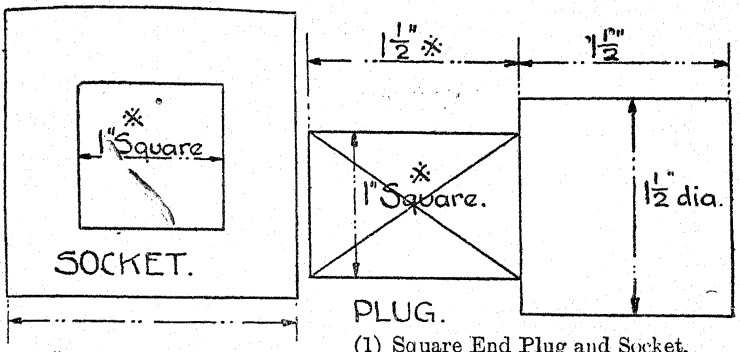
Name of firm or shop,_____

Period,_____

Nature of work,_____

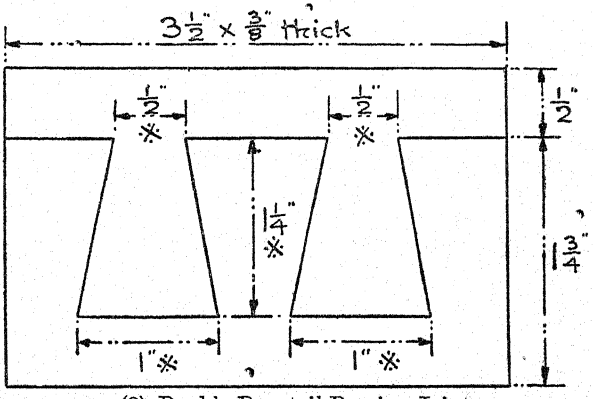
Signature of officer superintending the test.

_____

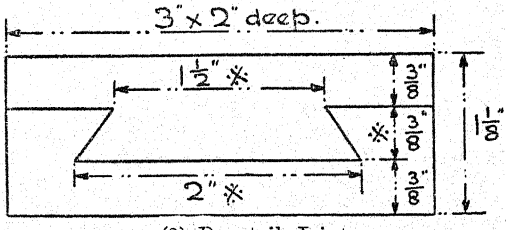


2" square × 1½" thick.

(1) Square End Plug and Socket.



(2) Double Dovetail Brazing Joint.



(3) Dovetail Joint.

NOTE :—Dimensions marked thus * to be accurately gauged ; other dimensions approximate.

SECTION VII.

Syllabuses of Courses of Instruction.

The following syllabuses are intended as a guide to the class of instruction given to artificers at the Ordnance College. Syllabus "A" is for all fitters, and includes turning work. Syllabus "B" is for smiths, and Syllabus "C" for wheelers and carpenters.

"A"—Fitters.

I.—1. Chipping and filing plane surfaces, forming hexagons, &c.
2. Cutting keyways and fitting keys and feathers.
3. Making fitters' tools.
4. Use of ratchet brace, stocks, dies, &c.
5. Repair of locks, and key fitting.

II.—1. General turning, including screw-cutting, and machine work generally.

III.—1. Brazing, use of plastic metal, soldering, and simple tinsmith's work.
2. Forging and tempering hand and machine tools.
3. Forging bolts, nuts, and rivets.
4. Riveting (hot and cold).
5. Making and tempering small springs.

IV.—1. General productive work on machinery repairs, &c.

(Time required for above, at least one year.)

There will be the following special additions to this syllabus :—

(*a*) *R.G.A. fitters.*

V.—Stoking and engine driving at the Ordnance College. (One month.)

VI.—Electricity. (One month.)

VII.—Petrol engine. (One month.)

VIII.—Steam lorry. (One month.)

IX.—Oil engine driving.

X.—Carriages, at the Royal Arsenal. (One month.)

(*b*) *R.H.A. and R.F.A. fitters.*

V.—1. Instruction in woodworking and use of wheelers' tools.
2. Repairs to woodwork of Q.F. equipment.
3. Making and shoeing wheels.
4. Painting and lettering.

VI.—1. Instruction in Q.F. equipment.

(Additional time for (*b*) (V. and VI.), six months.)

VII.—Electricity, at the Ordnance College. (Two weeks.)

"*B*"—*Smiths.*

I.—1. Scarfe and weld iron and steel.
2. Make and harden tools.
3. Brazing and soldering, and small amount of tinsmiths' work.
4. Use of plastic metal.
5. Use of stocks, dies, and taps.
6. Drilling and riveting.
7. Construction, care, and repair of forges.

II.—1. Specimen articles to be made for practice.

Bolts and nuts of all kinds.	Rivets of all kinds.
Swingletree work.	Guard irons.
Hinges.	Rave irons.
Scroll irons for springs.	Ironwork for poles.
Drag washers and linch pins.	Springs.
Splinter bar fittings and steps.	Chains and hooks.
Saddletree arches.	Bending tubing.

Wad hood worms or similar articles.
2. Simple angle-iron work.
3. Making tires and shoeing wheels.

III.—1. General productive work.

(Time required for the above, at least one year.)

There will be the following special additions to this syllabus :—

(*a*) *R.G.A. smiths* (as for (*a*) R.G.A. fitters, V. to X., previous page).

(*b*) *R.H.A. and R.F.A. smiths.*

IV.—Instruction in Q.F. equipment.

"*C*"—*Wheelers.*

I.—1. Make various kinds of joints.
2. Door-making and panelling.
3. Dovetailing.
4. Box and drawer-making.
5. Mortising and tenoning.
6. Make various mouldings.
7. Make handles for tools.
8. Wood-turning.
9. Care of tools.

II.—1. Make and shoe a wheel.
2. Fit slip spokes and felloes.
3. Make a section of a wheel.
4. Make saddletrees.
5. Examine and report on vehicles.

III.—1. Make rivets of all kinds.
2. Make bolts and nuts.
3. Use of stocks, dies, and taps.
4. Hardening cold chisels.

IV.—1. Lettering.
2. Mixing paints and painting.
3. Glass-cutting.

V.—General productive work.

(Time for the above, at least one year.)

Note.—IV. is omitted for wheelers of the Royal Engineers.

CHESTS, TOOL, FILLED. ARMAMENT ARTIFICERS. GARRISON ARTILLERY.

AUTHORITY, Paras. 14002 / 1.2.08 15010 / 1.5.10 15429 & 15430 / 1.5.11 & 16337 / 1.5.13 L. of C.

Description and Number.	S.
Section No. 7.	
Chest, tool, empty, No. 3... ...	1
Aprons, canvas, white	2
Blocks, scribing, with rectangular iron base	1
Braces, ratchet, 18 in.	1
Braces, ratchet, 18 in. drills, 1½ in.... ...	1
1⅜ in.... ...	1
1¼ in.... ...	1
1⅛ in.... ...	1
1 in.... ...	2
⅞ in.... ...	2
¾ in.... ...	2
⅝ in.... ...	2
½ in.... ...	2
⅜ in.... ..	2
¼ in.... ...	1
Tapping, 1 in.	2
⅞ in.	2
¾ in.	2
⅝ in.	2
½ in.	2
⅜ in.	2
Braces, ratchet, 18 in. drills, twist, square taper shank, 1⅝ in	1
1 in.	1
⅞ in.... ...	1
¾ in.... ...	1
⅝ in.... ...	1
½ in.... ...	1
⅜ in.... ...	1
¼ in.... ...	1
Braces, ratchet post, 24 in. ...	1
Braces, smiths	1
Callipers, pairs, 8 in. outside ...	1
5 in.	1
4 in., inside ...	1
4 in., outside ...	1
Cans, oil, lubricating, G.S. ...	1
Chisels, cross cut, 8″ × ⅜″ ...	1
Chisels, cross cut, 7″ × ¼″ ...	3
Chisels, engraving	1
Chisels, hand, cold, ¾″ × 8″ ...	4
Chisels, rivet, head	1
Compasses, wing, 10 in. ... pairs	1
Dividers, spring, 6 in. Mk. II. ...	1

Description and Number.	S.
Section No. 7—*cont.*	
Drifts, brass, round, ¾ in....	1
Drifts, brass, round, 1 in....	1
Drifts, steel, round, ¾ in....	1
Drifts, steel, round, 1 in....	1
Drills, twist, sets	1
Files, bastard, flat, 6 in.	3
Files, bastard, half-round, 6 in. ...	2
Files, bastard, knife, 6 in.	2
Files, bastard, round, 16 in. ...	1
Files, bastard, round, 14 in. ...	2
Files, bastard, round, 12 in. ...	2
Files, bastard, round, 10 in. ...	2
Files, bastard, round, 8 in. ...	2
Files, bastard, round, 6 in. ...	2
Files, bastard, square, 12 in. ...	2
Files, bastard, square, 8 in. ...	2
Files, bastard, warding, cut on one side, 4 in. ...	2
Files, bastard, warding, cut on one side, 3½ in. ...	2
Files, bastard, warding, cut on one side, 3 in. ...	2
Files, regular cut, hand, safe edge, tanged, 16 in....	1
Files, regular cut, hand, safe edge, tanged, 14 in....	2
Files, regular cut, hand, safe edge, tanged, 12 in....	2
Files, regular cut, half-round, 16 in....	1
Files, regular cut, half-round, 14 in....	1
Files, regular cut, half-round, 12 in....	1
Files, regular cut, half-round, 10 in....	1
Files, regular cut, half-round, 8 in....	1
Files, dead, smooth, flat, 12 in.... ...	1
Files, dead, smooth, ½-round, 4-in. ...	1
Files, dead, smooth, hand, safe edge, 4 in.	1
Files, fine cut, hand, safe edge, tanged, 14 in....	1
Files, fine cut, hand, safe edge, tanged, 12 in....	2
Files, fine cut, hand, safe edge, tanged, 10 in....	1
Files, fine cut, hand, safe edge, tanged, 8 in....	2
Files, fine cut, half-round, 12 in....	1
Files, fine cut, half-round, 10 in....	1
Files, fine cut, half-round, 8 in....	1
Files, saw, taper, 2nd cut, single, 6 in. ...	2
Files, saw, taper, 2nd cut, single, 4 in. ...	2
Files, saw, taper, 2nd cut, single, 3 in. ...	2
Files, 2nd cut, hand, safe edge, 6 in. ...	1
Files, 2nd cut, hand, safe edge, 4 in. ...	1

CHESTS, TOOL, FILLED. ARMAMENT ARTIFICERS. GARRISON ARTILLERY—*cont.*

AUTHORITY, Paras. 14002 1.2.08 | 15010 1.5.10 | 15429 & 15430 1.5.11 | & 16337 1.5.13 | L. of C.

Description and Number.	S.
Section No. 7—*cont.*	
Files, smooth, flat, 12 in.	1
Files, smooth, flat, 6 in.	1
Files, smooth, half-round, 12 in.	1
Files, smooth, half-round, 8 in.	2
Files, smooth, half-round, 6 in.	2
Files, smooth, hand, 8 in.	2
Files, smooth, safe edge, 4 in.	1
Flatters, smiths, Mark II	1
Fullers, smiths, large, bottom	1
Fullers, smiths, large, top	1
Hammers, fitters, 48 ozs. copper	1
Hammers, fitters, 24 ozs.	1
Hammers, fitters, 8 ozs.	1
Hammers, riveting, boilermakers, 3½ lbs.	1
Hammers, riveting, boilermakers, 2½ lbs.	1
Handles, file, large	5
Handles, file, middling	5
Handles, file, small	4
Handles, file, swan-neck	1
Holders, file, with handle, half-round, 16 in.	1
Holders, file, with handle, half-round, 14 in.	1
Holders, file, with handle, half-round, 12 in.	1
Holders, file, with handle, half-round, 10 in.	1
Holders, file, with handle, half-round, 8 in.	1
Irons, soldering, tinmans, large	1
Levels, spirit, adjustable	1
Oil stones, carpenters	1
Plates, screw, B.A. thread, sets	1
Pliers, round nose, pairs	1
Pliers, side-cutting, pairs	1
Pliers, 8 in., Mk. IV cutters	2
Punches, centre 4½ in.	2
Punches, round ½″ × 10″	1
Punches, smiths, cold	2
Rules, armament artificers, 2 ft.	1
Rules, smiths	1

Description and Number.	S.
Section No. 7—*cont.*	
Saws, hack, 12 in.	1
Saws, hack, blades, 12 in.	6
Screwdrivers, G.S., 14 in.	1
Scribers	1
Snaps, riveting, rods, 1 in.	1
Snaps, riveting, rods, ⅞ in.	1
Snaps, riveting, rods, ¾ in.	1
Snaps, riveting, rods, ⅝ in.	1
Snaps, riveting, rods, ½ in.	1
Spanners, A.A. double-ended, 1 in. and ⅞ in.	1
Spanners, A.A. double-ended, ¾ in. and ⅝ in.	1
Spanners, A.A. double-ended, ½ in. and ⅜ in.	1
Spanners, adjustable, 15 in.	1
Squares, box, fitters	1
Squares, fitters, 4 in.	1
Squares, smiths, 18″ × 9″	1
Stocks, drill, breast	1
Stocks, drill, hand, Mk. II	1
Straightedges, steel, 2 ft.	1
Tongs, wheelers, fitters pairs	1
Vices, hand, 20 ozs.	1
Vices, hand, combination	1
Wrenches, pipe, flat link, ¼ in. to 2½ in.	1
Handbook, military artificers	1
Section No. 9.	
Cloth, emery, No. F. sheets	6
Section No. 13.	
Cloths, sponge	6
Section No. 15.	
Clinometers, large	1
Cases, large, clinometer	1

CHESTS, TOOL, FILLED. BRICKLAYERS AND MASONS.

AUTHORITY, Para. 14002/1.2.08 L. of C.

Description and Number.	S.	Description and Number.	S.
Section No. 7.		**Section No. 7—*cont.***	
Chest, tool, empty, No. 2	1	Rules, G.S., 4-fold	1
Bar, setting	1	Rules, masons, plumb, 2 ft. 6 ins.	1
Bevel, wood, blade, 12 in.	1	Squares, smiths, 2′ 0″ × 6″	1
Bolsters, bricklayers	1	Trowels, bricklayers, 12 in.	1
Chisels, hand, cold, 1″ × 12″	1	Trowels, bricklayers, pointing, cross joint	1
Compasses, wing, 7 in. pairs	1	Trowels, bricklayers, pointing, tuck	1
Hammers, chisel point, 5 lbs.	1	Trowels, masons	1
Hammers, masons, mash	1	Trowels, plasterers set	1
Levels, spirit, rule (with leather case)	1	**Section No. 11.**	
Lines, bricklayers	1	Brushes, white-wash, hair, 6 ozs.	1
Pins, line pairs	1	Brushes, white-wash, bristle	1
Points, masons	2		

CHESTS, TOOL, FILLED. CARPENTERS AND WHEELERS.

AUTHORITY, Paras. 14002/1.2.08 15010/1.5.10 15429/1.5.11 15430/1.5.11 & 16337/1.5.13 L. of C.

Description and Number.	S.	Description and Number.	S.
Section No. 7.		**Section No. 7—*cont.***	
Chest, tool, empty, No. 3	1	Axes, hand, 3 lbs.	1
Adzes, carpenters, heads, Mark II	1	Baskets, tool, web handled	1
Adzes, carpenters, handles, 29 in.	1	Bevels, steel blade, slotted, 10½ in.	1
Aprons, canvas, white	2	Braces, carpenters, ratchet, with 24 bits	1
Augors, screw, solid wing, eyed, 1½ in.	1	Callipers, 5 in. pairs	1
Augors, screw, solid wing, eyed, 1⅛ in.	1	Cans, oil, lubricating, G.S.	1
Augors, screw, solid wing, eyed, 1 in.—29 in. long	1	Chisels, firmer, coach-makers, 1½ in.	1
Augors, screw, solid wing, eyed, ⅞ in.	1	Chisels, firmer, coach-makers, 1¼ in.	1
Augors, screw, solid wing, eyed, ¾ in.	1	Chisels, firmer, coach-makers, 1 in.	1
Augors, screw, solid wing, eyed, ⅝ in.	1	Chisels, firmer, coach-makers, ¾ in.	1
Augors, screw, solid wing, eyed, ½ in.	1	Chisels, firmer, coach-makers, ⅝ in.	1
Augors, handles, 16 in.	1	Chisels, firmer, coach-makers, ½ in.	1
Augors, handles, 13¾ in.	1	Chisels, cross cut, 7″ × ¼″	2
Augors, handles, 12 in.	1	Chisels, hand, cold, ¾″ × 8″	2
Awls, blades, brad	12	Compasses, wing, 7 in. pairs	1
Awls, handles, brad, large	2		
Awls, handles, brad, small	2		

CHESTS, TOOL, FILLED. CARPENTERS AND WHEELERS—*cont.*

AUTHORITY, Paras. 14002/1.2.08 15010/1.5.10 15429/1.5.11 15430/1.5.11 & 16337/1.5.13 I. of C.

Description and Number.	S.
Section No. 7—*cont.*	
Drifts, steel, round, 5/16 in.	1
Drifts, steel, round, 7/16 in.	1
Drifts, steel, round, 9/16 in.	1
Drifts, steel, round, 11/16 in.	1
Drifts, steel, round, 13/16 in.	1
Files, regular cut, hand, safe edge, tanged, 14 in.	1
Files, regular cut, half-round, 14 in.	1
Files, bastard, 10 in.	1
Files, round, 6 in.	1
Files, saw, taper, 2nd cut, single, 6 in.	4
Files, saw, taper, 2nd cut, single, 4 in.	4
Gauges, carpenters, marking	1
Gauges, carpenters, mortice	1
Gimlets, twist, No. 1	1
Gimlets, twist, „ 3	1
Gimlets, twist, „ 5	1
Gouges, handled, firmer, 1 in.	1
Gouges, handled, firmer, ½ in.	1
Gouges, handled, firmer, ¼ in.	1
Hammers, carpenters	1
Hammers, fitters, 32 ozs.	1
Hammers, fitters, 16 „	1
Hammers, fitters, 8 „	1
Hammers, handles, No. 6	1
Handles, file, large	1
Handles, file, middling	2
Handles, file, small	1
Holders, file, with handle, ½-round, 14 in.	1
Knives, drawing, carpenters, Mark I	1
Lines, carpenters	1
Mallets, carpenters	1
Oil stones, carpenters	1
Oil stones, slip, Turkey	1

Description and Number.	S.
Section No. 7—*cont.*	
Pencils, carpenters	6
Pincers, carpenters ... pairs	1
Planes, jack, double iron	1
Planes, plough	1
Planes, rabbet, skew	1
Planes, smoothing, G.S.	1
Pliers, side-cutting, 8 in., Mark IV, pairs	1
Pliers, side-cutting, 8 in., Mark IV, cutters	2
Pots, glue, 1 pint	1
Punches, centre, 4½ in.	1
Punches, carpenters, small	1
Rasps, rough, ½-round, 12 in.	1
Reels, carpenters, line	1
Rules, G.S., 4-fold	1
Saws, compass	1
Saws, dovetail, brass back	1
Saws, hand, 26 in.	1
Saws, tenon, 14 in.	1
Screwdrivers, G.S., 14 in.	1
Screwdrivers, G.S., 6 in.	1
Scribers	1
Sets, saw, hand	1
Spanners, adjustable, 15 in.	1
Spokeshaves, 3½ in.	1
Squares, carpenters, 9 in.	1
Tongs, wheelers, fitters ... pairs	1
Handbooks, military artificers	1
Section No. 9.	
Chalk, white ... lbs.	¼
Section No. 11.	
Brushes, paint, sash tool No. 6	1
Section No. 13.	
Cloths, sponge	4

CHESTS, TOOL, FILLED. CARPENTERS.

AUTHORITY, PARAS. $\frac{14002}{1.2.08}$ $\frac{15010}{1.5.10}$ & $\frac{15430}{1.5.11}$ L. of C.

Description and Number.	S.
Section No. 7.	
Chests, tool, empty, No. 4 ...	1
Aprons, canvas, white	2
Adzes, { heads, Mark II ...	1
carpenters, { handles, 29 in. ...	1
Augers, { screw, { 1¼ in. ...	1
Augers, { screw, { 1 in.—29 in. long	1
Augers, { solid wing, eyed, { ⅜ in.	1
Augers, { handles, { 16 in.	1
Augers, { handles, { 13½ in.	1
Awls, { blades, brad (Nos. 2, 4, and 6)	3
Awls, { handles, brad, { large ...	1
Awls, { handles, brad, { small ...	2
Baskets, tool, web-handled ...	1
Braces, carpenters, ratchet, with 24 bits	1
Cans, oil, lubricating, small ...	1
Chisels, { hand, cold, ¾″ × 8″ ...	1
Chisels, { firmer, coach-makers, { 1½ in.	1
Chisels, { firmer, coach-makers, { ⅜ in.	1
Compasses, wing, 7 in. ... pairs	1
Files, regular cut, H.S.E., tanged, 12 in.	1
Files, saw, taper, 2nd cut, single, { 6 in. ...	3
Files, saw, taper, 2nd cut, single, { 4 in. ...	3
Gimlets, twist, { No. 1	1
Gimlets, twist, { „ 3	1
Gimlets, twist, { „ 5	1
Hammers, { carpenters	1
Hammers, { riveting, 24 ozs. ...	1

Description and Number.	S.
Section No. 7—*cont.*	
Handles, file, { middling	1
Handles, file, { small	2
Knives, drawing, carpenters, Mark I	1
Lines, carpenters	1
Mallets, carpenters	1
Oil stones, carpenters	1
Pencils, carpenters	6
Pincers, carpenters ... pairs	1
Planes, jacks, double iron ...	1
Punches, carpenters, small ...	1
Reels, carpenters, line	1
Rules, G.S., 4-fold...	2
Saws, { hand, 26 in.	1
Saws, { tenon, 14 in.	1
Screwdrivers, G.S., 12 in. ...	1
Sets, saw, hand	1
Spanners, adjustable, 15 in. ...	1
Spokeshaves, 3½ in.	1
Squares, carpenters, 9 in.... ...	1
Section No. 9.	
Chalk, white ... ... lbs.	¼
Section No. 10.	
Padlocks, iron, 2 in.	1

CHEST, TOOL, FILLED. COOPERS.

AUTHORITY, Paras. $\frac{14002}{1.2.08}$ & $\frac{15010}{1.5.10}$ L. of C.

Description and Number.	S.
Section No. 7.	
Chest, tool, empty, No. 6	1
Adzes, coopers, { nailing*	1
notching, Mark II ...	1
rounding, Mark II ...	1
trussing	1
Aprons, canvas, white	2
Axe, coopers, Mark II	1
Braces, carpenters, ratchet, without bits	1
Braces, carpenters, bits, { centre, 1 in. ...	1
brewers, gimlet, tanged	1
Borers, bung	1
Chisels, hand, cold, 1″ × 8½″ ...	1
Chives, coopers, Mark II... ...	1
Compases, wing, 12 in. ... pairs	1
Drivers, coopers, socket iron, Mark II	1
Files, saw, taper, 2nd cut, single, 6 in.	2
Hammers, { coopers, hand, 3½ lbs.*	1
riveting, 8 ozs. ...	1

Description and Number.	S.
Section No. 7—*cont.*	
Handles, file, small	1
Irons, { bick upon wood ...	1
chintzing	1
flagging	1
Jiggers, coopers, Mark II ...	1
Jointers, F.S.	1
Knives, { drawing, coopers, Mk. II	1
hollowing	1
Oil stones, carpenters	1
Pincers, carpenters ... pairs	1
Planes, topping, coopers	1
Punches, coopers, small	1
Rules, G.S., 4-fold...	1
Saw, hand, 26 in.	1
Shaves, coopers, { inside cask, Mark II	1
outside cask, Mark II	1
round	1
Stocks, { barrel, Mark II ...	1
croze, { pail	1
Stones, rag	1
Vices, screw, iron	1

*Added *vide* $\frac{57}{28}$ $\frac{\text{P.I.W.}}{7/80}$ & $\frac{57}{21}$ $\frac{\text{P.I.W.}}{7/83}$
$\frac{472}{2}$ $\frac{2}{}$ $\frac{470}{2}$ $\frac{2}{}$

CHEST, TOOL, FILLED. FARRIERS & SHOEING SMITHS.

AUTHORITY, Paras. 14002 / 1.2.08 L. of C. & 57 / Gen. No. 408 P.I.W. 7/238 10/6/11. 1

Description and Number.		Description and Number.	
Section No. 7.	S.	Section No. 7.—*cont.*	S.
Chest, tool, empty, No. 7... ...	1	Pincers, farriers ... ... pairs	1
Aprons, basil, brown	1	Pokers, smiths	1
Bags, tool, farriers	1	Pritchels, farriers	3
Buffers, farriers	1	Rasps, farriers, 16-in.	2
Chisels, farriers, handled ...	1	Slices, farriers	1
Cutters, anvil, ½-round, farriers, small shank	2	Stamps, farriers	2
Hammers, farriers, shoeing	1	Stones, rag, farriers	1
Hammers, farriers, sledge, 9½ lbs. ...	1	Tongs, farriers, pairs — fire	1
Hammers, farriers, turning	1	Tongs, farriers, pairs — turning — large ...	1
Knives, farriers, drawing ...	2	Tongs, farriers, pairs — turning — medium	1
Knives, farriers, searching ...	1	Tongs, farriers, pairs — turning — small ...	1

CHEST, TOOL, FILLED. SADDLETREEMAKERS.

APPROVED 54 / Gen. No. 3026 and 57 / Gen. No. 2578 19TH SEPTEMBER, 1902 and

Paras. 14002 L. of C. 1.2.08. / 14145 L. of C. 1.6.08.

Description and Number.		Description and Number.	
Section No. 7.	S.	Section No. 7—*cont.*	S.
Chests, tool, empty, No. 4 ...	1	Handles, file, large	1
Braces, carpenters, ratchet, without bits	1	Handles, file, small	1
Braces, carpenters, bits, counter-sink, flat	1	Holdfasts, carpenters	1
Braces, carpenters, bits, counter-sink, rose	1	Mallets, carpenters	1
Braces, carpenters, bits, nose, ¼ in. ...	1	Pencils, carpenters	3
Braces, carpenters, bits, nose, 5/16 in. ...	1	Planes, smoothing, G.S.	1
Braces, carpenters, bits, nose, ½ in. ...	1	Pots, glue, 1 pint	1
Braces, carpenters, bits, rimer, square ...	1	Punches, tinmans, flat end, large	1
Brushes, hair, flat, 2-in.	1	Rules, smiths	1
Chisels, firmer, 1 in.	1	Saws, dovetail, brass back ...	1
Chisels, firmer, ¾ in.	1	Saws, frame, 15 in.	1
Chisels, firmer, ⅜ in.	1	Shave, spoke, 4 in.	1
Chisels, hand, cold, ¾″ × 8″ ...	1	Scrapers, cabinet makers... ...	1
Compasses, common, 7 in. pairs	1	Stones, oil, carpenters	1
Drivers, screw, G.S., 6 in. ...	1	Squares, carpenters, 6 in. ...	1
Files, bastard, half-round, 14 in.	1	Vice, bench, saddletreemakers ...	1
Files, saw, taper, 2nd cut, single, 4 in.	1	Section No. 10.	
Hammers, riveting, 16 ozs. ...	1	Locks, pad, iron, 2 in.	1
Hammers, riveting, saddle seat	1	Section No. 11.	
		Brushes, paint, sash tool, No. 6...	1

CHESTS, TOOL, FILLED. SMITHS.

AUTHORITY, Paras. { 14002 / 1.2.08 | 15010 / 1.5.10 | 15087 / 1.7.10 | 15429 / 1.5.11 | 15430 / 1.5.11 | 16099 / 1.10.12 | 16337 / 1.5.13 | L. of C. & 57 / 21 / 462

Description and Number.	S.
Section No. 7.	
Chest, tool, empty, No. 11 ...	1
Aprons, basil, brown	4
Braces, ratchet, 9 in.	1
Braces, ratchet, 12 in. drills ... sets	1
Braces, ratchet, posts, 16 in., Mark II...	1
Braces, smiths	1
Braces, smiths, bits, countersink, rose	1
Braces, smiths, bits, rimer, half-round	1
Braces, smiths, bits, rimer, square ...	1
Callipers, pairs, 10 in.	1
Callipers, pairs, 5 in.	1
Cans, oil, lubricating, G.S. ...	1
Chisels, cross cut, 7″ × ¼″ ...	1
Chisels, engraving	1
Chisels, hand, cold, 1″ × 8½″	1
Chisels, hand, cold, ¾″ × 8″ ...	1
Chisels, rivet head	1
Chisels, smiths, with hot...	1
Chisels, smiths, with wood handle cold	1
Compasses, wing, 10 in. ... pairs	1
Cutters, anvil, flat, smiths, with screwed setting gauge	1
Files, bastard, flat, 6 in.	1
Files, bastard, round, 10 in. ...	1
Files, bastard, round, 8 in. ...	1
Files, regular cut, hand, safe edge, tanged, 14 in. ...	2
Files, regular cut, half-round, 14 in.	1
Files, regular cut, half-round, 10 in.	1
Files, fine cut, half-round, 8 in. ...	1
Files, 2nd cut, hand, safe edge, 6 in.	1
Flatters, smiths, Mark II ...	1
Fullers, smiths, F.S., bottom ...	1
Fullers, smiths, F.S., top ...	1
Hammers, fitters, 32 ozs. ...	1
Hammers, fitters, 24 „ ...	1
Hammers, fitters, 8 „ ...	1
Hammers, smiths, sledge, 10 lbs.	1
Hammers, smiths, uphand, 7 „	1
Handles, file, large	1
Handles, file, middling	2
Handles, file, small	1
Holders, rivet head, small ...	1
Holders, file, with handle, ½-round, 14 in.	1
Holders, file, with handle, ½-round, 10 in.	1
Holders, file, with handle, ½-round, 8 in.	1

Description and Number.	S.
Section No. 7—*cont.*	
Plates, screw, B.A. thread, sets ...	1
Pliers, side cutting, 8 in., Mark IV, pairs	1
Pliers, side cutting, 8 in., Mark IV, cutters	2
Pokers, smiths	1
Punches, centre, 4½ in.	1
Punches, round ½″ × 10″ ...	1
Punches, round 1/16″ × 4″ ...	1
Punches, smiths, hot, ⅛ in....	1
Punches, smiths, hot, ⅜ in....	1
Rods, smiths, iron	4
Rules, armament artificers, 1-ft.	1
Rules, smiths	1
Saws, 12-in.	1
Saws, blades, 12-in.	6
Screwdrivers, G.S., 14 in. ...	1
Screwdrivers, G.S., 6 in. ...	1
Scribers	1
Slices, farriers	1
Snaps, 1/16 in....	1
Snaps, hand, ⅛ in.	1
Snaps, riveting, ¼ in.	1
Snaps, riveting, rod ¾ in.	1
Snaps, riveting, rod ⅝ in.	1
Spanners, adjustable, 15 in. ...	1
Squares, box, fitters	1
Squares, fitters, 4 in	1
Squares, smiths, 18″ × 9″ ...	1
Stones, rag	2
Tongs, smiths, pairs, forebit	1
Tongs, smiths, pairs, forge, small	1
Tongs, smiths, pairs, hollow bit	1
Tongs, smiths, pairs, plier, Mark II... ...	1
Tools, forming	1
Tools, rounding, bottom...	1
Tools, rounding, Mark II, top ...	1
Travellers	1
Vices, hand, 16 ozs.	1
Vices, bench, saddletreemakers	1
Not in Vocabulary.	
Handbooks, military artificers ...	1
Section No. 13.	
Cloths, sponge	4

CHEST, TOOL, FILLED. PLUMBERS.

AUTHORITY, Paras. 14002 L. of C. d/1.2.08 & $\frac{57}{\text{Gen. No. } 1189}$

Description and Number.	S.	Description and Number.	S.
Section 7.		**Section No. 7—*cont.***	
Chest, tool, empty, No. 12	1	Knives, cutting	1
Aprons, canvas, white	2	Ladles, melting, ½ pint	1
Awls, scoring, brass	1	Mallets, tinmans	1
Blow pipes, 12 in.	1	Mallets, plumbers, Mark II	1
Bosses, plumbers, 2¼ in.	1	Moleskin, wiping	1
Chisels, smiths, with wood handle, cold	1	Pliers, pairs, gas, 9″	1
Compasses, wing, 7 in. pairs	1	Pliers, pairs, round nose	1
Dressers, plumbers, Mark II	1	Pots, fire, tinmans	1
Groovers, tinmans, large	1	Pots, melting, 3 pints	1
Groovers, tinmans, small	1	Punches, tinmans, flat end, large	1
Hammers, riveting, 16 ozs.	1	Punches, tinmans, flat end, small	1
Hammers, riveting, 4 ozs.	1	Shears, tinmans, snip pairs	1
Hammers, tinmans, block, 3 lbs. 6 ozs.	1	Snaps, hand, riveting, tinmans	1
Hooks, shave, 1½ in.	1	Stakes, tinmans, hatchet, Mark II	1
Iron, soldering, hatchet shape	1	Sticks, bossing	1
Iron, soldering, plumbers, 1¼ lbs.	1	Wrenches, adjustable, 9 in.	1
Iron, soldering, tinmans, large	1	Wrenches, pipe, flat link, ½ in. to 1½ in.	1

CHEST, TOOL, FILLED. PAINTERS AND GLAZIERS.

AUTHORITY, Para. 14002/1.2.08 L. of C.

Description and Number.	S.	Description and Number.	S.
Section No. 7.		**Section No. 7—*cont.***	
Chest, tool, empty, No. 13	1	Pliers, flat nose pairs	1
Aprons, canvas, white	2	Pots, writing	1
Brushes, writing, red sable, crow	3	Rules, glaziers, T., 2 ft.	1
Brushes, writing, red sable, duck	3	**Section No. 11.**	
Brushes, writing, sable duck, large	3	Brushes, oval	4
Brushes, writing, sable duck, small	3	Brushes, unground, 000	2
Cans, paint, 7½ in. diam.	1	Brushes, paint, sash tool, No. 2	2
Cans, paint, 7 „ „	1	Brushes, paint, sash tool, „ 8	1
Cases, diamond, Mark II	1	N.B.—The undermentioned does not form part of the chest, but when required may be demanded and accounted for separately:—	
Diamond, glaziers, large	1	**Section No. 7.**	
Hammers, riveting, 8 ozs.	1	Lamps, brazing, 1 pint (per chest)	1
Knives, chisel, 3 in.	1		
Knives, hacking	1		
Knives, palette, 9 in.	1		
Knives, stopping	1		
Knives, putty	1		

CHESTS, TOOL, FILLED. ARMAMENT ARTIFICERS POSITION-FINDING.

AUTHORITY, Paras. 10128 / 1.5.00 14002 / 1.2.08 15010 / 1.5.10 & 15436 / 1.5.11 L. of C.

Description and Number.	S.
Weedon Section.	
Boxes, oilstone, dust	1
Sticks, buff	6
Dust, oilstones ... ... lbs.	½
Oilstones, slip, Arkansas, small	2
Section No. 3.	
Brass, sheet, No. 6 S.W.G. lbs.	†2
Brass, sheet, „ 10 „ „	†2
Brass, sheet, „ 14 „ „	†1
Brass, sheet, „ 18 „ „	†1
Copper, sheet, No. 16 S.W.G. „	†2
Solder, tinmans, soft ... „	1
Steel rods, bright, No. E... „	½
Steel rods, bright, „ 3... „	½
Steel rods, bright, „ 27... „	½
Steel rods, bright, „ 32... „	½
Steel rods, bright, „ 42... „	½
Steel rods, bright, „ 49... „	½
Tin, grain ... ... „	1
Wire, ordinary, brass, hard, No. 3 S.W.G. „	†1
Wire, ordinary, brass, hard, „ 6 „ „	†1
Wire, ordinary, brass, hard, „ 9 „ „	†1
Wire, ordinary, brass, hard, „ 11 „ „	†1
Wire, ordinary, brass, hard, „ 13 „ „	†1
Wire, ordinary, brass, hard, „ 15 „ „	†1
Silver, German, sheet (hard rolled), lbs. No. 14 S.W.G....	1
Silver, German, sheet (hard rolled), lbs. „ 21 „ ...	1
Section No. 7.	
Anvil, ¼-cwt.	1
Awls, blades, brad	12
Awls, handles, brad, large ...	6
Awls, handles, brad, small ...	6
Blocks, anvil, ¼-cwt.	1
Blocks, scribing, with round gun-metal base ...	1
Boxes, polishing	1
Braces, carpenters, ratchet, with 24 bits	1

Description and Number.	S.
Section No 7—*cont.*	
Broaches, tele. mechanics, blades sets	1
Broaches, tele. mechanics, handles ...	12
Broaches, round, No. 8 S.W.G. ...	2
Broaches, round, „ 10 „ ...	2
Broaches, round, „ 12 „ ...	2
Broaches, round, „ 14 „ ...	2
Broaches, round, „ 16 „ ...	2
Broaches, round, „ 18 „ ...	
Broaches, round, „ 20 „ ...	
Brushes, hair, flat, 1½ in. ...	
Brushes, hair, flat, 1 „ ...	1
Brushes, hair, flat, ½ „ ...	1
Callipers, 4 in. inside ... pairs	1
Callipers, 4 in. outside ... „	1
Card, scratch ... ... feet	1
Chests, tool, empty, No. 14 ...	1
Chisels, firmer, 1 in. ...	1
Chisels, firmer, ¾ „ ...	1
Chisels, firmer, ½ „ ...	1
Chisels, firmer, ¼ „ ...	1
Chisels, hand, cold, ¾ in. × 8 in.	1
Chisels, socket, ¼ in.	1
Files, bastard, hand, safe edge, 4 in	1
Files, bastard, round, 10 in. ...	1
Files, bastard, round, 6 „ ...	2
Files, bastard, square 8 in. ...	1
Files, saw, taper, 2nd cut, single, 6 in.	2
Files, 2nd cut, half-round, 6 in....	1
Files, 2nd cut, hand, safe edge, 6 in.	1
Files, 2nd cut, square, 8 in. ...	1
Files, dead smooth, flat, 12 in.	1
Files, dead smooth, flat, 6 „	2
Files, dead smooth, ½-round, 6 „	1
Files, dead smooth, ½-round, 4 „	1
Files, dead smooth, hand, 6 „	1
Files, dead smooth, safe edge, 4 „	2

† See page 177.

CHESTS, TOOL, FILLED. ARMAMENT ARTIFICERS, POSITION-FINDING—*cont.*

AUTHORITY, Paras. 10128 I.5.00 | 14002 I.2.08 | 15010 I.5.10 & 15430 I.5.11 L. of C.

Description and Number.	S.
Section No. 7—*cont.*	
Files, smooth, flat, 12 "	1
Files, smooth, flat, 8 "	2
Files, smooth, ½-round, 12 "	1
Files, smooth, ½-round, 6 "	2
Files, smooth, ½-round, 4 "	2
Files, smooth, hand, 8 "	1
Files, smooth, safe edge, 4 "	4
Files, smooth, round, 6 "	2
Files, smooth, round, 3 "	2
Files, smooth, square, 6 "	2
Files, smooth, square, 4 "	2
Files, smooth, 3-square, 4 in. ...	2
Files, regular cut, flat tanged, 16 in.	1
Files, regular cut, flat tanged, 14 "	1
Files, regular cut, ½-round, 12 in. ...	1
Files, fine cut, flat tanged, 12 in.	1
Files, fine cut, flat tanged, 8 "	2
Files, fine cut, ½-round, 10 in. ...	1
Gauges, wire (for workshops) ...	1
Gimlets, twist, No. 1	2
Gimlets, twist, " 2	2
Gimlets, twist, " 3	2
Gimlets, twist, " 4	2
Gimlets, twist, " 5	2
Gimlets, twist, " 6	2
Gouges, handled, firmer, ½ in. ...	1
Gouges, handled, firmer, ¾ " ...	1
Gouges, handled, firmer, 1¼ " ...	1
Gouges, handled, flat, ½ " ...	1
Gouges, handled, flat, ¾ " ...	1
Gravers, ⅜ in.	1
turners, ⅞ "	1
Grindstones, 8 in.	†1
Hammers, fitters, 16 ozs. ...	1
Hammers, watchmakers ...	1
Handles, file, large ...	4
Handles, file, middling ...	4
Handles, file, small ...	4
Handles, graver ...	12
Holders, file, with handle, ½-round, 12 in. ...	1
Holders, file, with handle, ½-round, 10 " ...	1
Holders, milling tool ...	1
Irons, soldering, tinmans, small ...	1
Ladles, melting, half-pint ...	†1

Description and Number.	S.
Section No. 7—*cont.*	
Lathes, watchmakers, arm	1
Lathes, watchmakers, mandril ...	1
Lathes, watchmakers, wheel	1
Mallets, tinmans	1
Planes, smoothing, G.S.	1
Plates, surface, 10" × 4" ...	1
Pliers, watchmakers, 5 in. ... pairs	1
Pliers, watchmakers, 4 " ... "	1
Pots, fire, telegraph mechanics ...	†1
Rasps, rough, flat, 8 in. ...	1
Rasps, rough, ½-round, 8 in.	1
Rasps, 2nd cut, flat, 6 in. ...	1
Rasps, 2nd cut, ½-round, 6 in.	1
Runners, milling, flat ... ... sets	1
Runners, milling, hollow ... "	1
Runners, milling, round ... "	1
Saws, cutting metal, 6 in.	1
Saws, cutting metal, blades, 6 in. ...	2
Saws, dovetail, brass back ...	1
Saws, hand, 26 in.	1
Saws, keyhole	1
Saws, keyhole, blades	2
Screwdrivers, watchmakers, ¼ in. ...	1
Screwdrivers, watchmakers, ⅜ " ...	1
Screwdrivers, watchmakers, ⅛ " ...	1
Sets, saw, hand	1
Shears, snip ... ... pairs	1
Spokeshaves, 3½ in.	1
Squares, carpenters, 9 in. ...	1
Straightedges, steel, 2 ft. ...	1
Tongs, watchmakers, wide nose ... ... pairs	1
Tools, watchmakers, carriers ... ... sets	1
Tools, watchmakers, cups	1
Tools, watchmakers, drills ... ... sets	1
Tools, watchmakers, files, Geneva, cyl. notch	2
Tools, watchmakers, files, Geneva, dovetail	2
Tools, watchmakers, files, Geneva, ratchet ...	2
Tools, watchmakers, files, Geneva, round ...	2
Tools, watchmakers, files, Geneva, square ...	2
Tools, watchmakers, files, Geneva, 3-square	2
Tools, watchmakers, files, screw-head, No. 0 and 1 (2 of each)	4
Tools, watchmakers, glass covering	1
Tools, watchmakers, jars	1
Tools, watchmakers, tongs, pin	1
Vices, bench, parallel, 12-lbs. ...	†1

† See page 177.

CHESTS, TOOL, FILLED. ARMAMENT ARTIFICERS, POSITION-FINDING—*cont.*

AUTHORITY, Paras. $\frac{10128}{1.5.00}$ $\frac{14002}{1.2.08}$ $\frac{15010}{1.5.10}$ & $\frac{15450}{1.5.11}$ L. of C.

Description and Number.	S.
Section No. 8.	
Compasses, prismatic, { Mark V	1
{ case... ...	1
Section No. 9.	
Borax, refined ... ... lbs.	½
Bottles, { glass, stoppered, { 2-ozs.	2
{ wide mouth, { 4 „	2
{ stone, 1-pt. (for soldering sol.)	1
Cloth, emery, sheets, { No. F. (fine) ...	6
{ „ 1 (mild) ...	6
Compound, Chatterton's ... lbs.	2
Mineral jelly, red (in 1-lb. tins)	2
Oil, { clock ... ... small bot.	1
{ watch ... „ „	1
Wax, paraffin, white ... lbs.	1
Resin, black...	½
Paper, emery, sheets, { No. 0	6
{ „ 1	6
{ „ 2	6
{ „ 3	6
Powder, emery, flour ... lbs.	½
Sticks, emery, { No. 00	6
{ „ 0	6
{ „ 1	6
{ „ 2	6
Zinc, chloride solution ... pints	1
Wick, common (for spirit lamp) lbs.	½
Section No. 12.	
Stamps, steel, for metal, { ⅛ in., figs. 0 to 8 sets	1
{ ⅛ in. letters „	1
Section No. 13.	
Cloths, sponge	12
Leather, chamois	3

Description and Number.	S.
Section No. 26.	
Shellac, orange ... ... lbs.	¼
Section No. 28.	
Apparatus, range finding dial, mechanical, A	†1
Boxes, range finding, artificers, filled	*1
Coils, resistance, 10,000 ohms. ...	†1
Galvanometer, detector, quantity and intensity	1
Galvanometer, detector, case, quantity and intensity	1
Galvanometer, horizontal... ...	1
Ebonite, unpolished, { bar, 2 in. feet	1
{ rod, { ⅝ in. „	1
{ ⅜ „ „	1
Lamps, blow, spirit, Mark II ...	1
Volt-ammeter, Mark I	1
Wire, electric, Q. 13 ... yards	5
„ „ X. 31 ... ozs.	1
Section No. 29.	
Boxes, { borax	1
{ resin	1
Chisels, hand, cold, ½″ × 4½″ ...	1
Elderpith ... ... bundles	3
Pegwood ... ... „	6
Stocks and dies, Whitworth thread, telegraph mechanics sets	1
Cases, boxwood, files	1
Tweezers, large ... ... pairs	1
Section No. 30.	
Rags, cotton... ... ... lbs.	‡2

*, †, ‡ See page 177.

CHESTS, TOOL, FILLED. ARMAMENT ARTIFICERS, POSITION FINDING—*cont.*

AUTHORITY, Paras. $\frac{10128}{1.5.00}$ $\frac{14002}{1.2.08}$ $\frac{15010}{1.5.10}$ & $\frac{15430}{1.5.11}$ L. of C.

Description and Number.	Description and Number.
Notes. * Each chest will be accompanied by a filled "Box, R.F. Artificers." For the contents of the box, *see* Appendix XVII., Section 12A, Part II., Equipment Regulations. The consumable stores contained therein will be demanded as may be necessary from time to time, to ensure that the supply in the box shall not fall below 50 per cent. of the full complement. Stores marked thus † will be packed in a suitable case to accompany the Chest A.A.P.F.	‡ *To be provided locally.* The undermentioned inflammable stores, if required, may be demanded from the nearest Ordnance Depôt, *vide* 54 / Gen. No. / 9977 — W / 9408 / 21/5/06 or obtained locally as required, *vide* A.O., d./1/5/07. Lacquer, pale gold ... pints ½ Lacquer, white ... ... „ 1 Methylated spirits... ... galls. 1 Solution, bronzing ... pints 1 Bottles, stone, 1-pint ... 1 Bottles, stone, ½ „ ... 3 Bottles, tin, oil, 1-gall.... ... 1

PANNIERS, TOOL, FILLED, SADDLERS.

AUTHORITY, Para. 12,476, L. of C., 1.12.1904.

Description and Number.	S.	Description and Number.	S.
Detail of Pannier.		Detail of Pannier—*cont.*	
Pannier, tool, empty, saddlers (with padlock and key) ...	1	Awls, handles, drawing	4
Aprons, canvas, white	1	Awls, handles, harness	4
Awl, blades, buckling, 4 inch ...	3	Awls, handles, pannel	4
Awl, blades, buckling, 5 „ ...	3	Bones, hollow	1
Awl, blades, drawing	2	Chisels, hand, cold, ¾″ × 8″ ...	1
Awl, blades, garnishing, 2¼ inch...	2	Clams, saddlers ... ... pairs	1
Awl, blades, garnishing, 2 „ ...	2	Claw, nail	1
Awl, blades, harness, 3 „ ...	3	Compasses, wing, 7 inch... pairs	1
Awl, blades, harness, 2¾ „ ...	4	Creases, double	1
Awl, blades, harness, 2½ „ ...	4	Creases, single	1
Awl, blades, harness, 2¼ „ ...	4	Gimlets, common, No. 6	1
Awl, blades, harness, 2 „ ...	3	Hammers, riveting, 8 ozs. ...	1
Awl, blades, pannel, 7 „ ...	2	Hammers, saddlers	1
Awl, blades, pannel, 5½ „ ...	2	Holdalls, tool, saddlers	1

PANNIERS, TOOL, FILLED, SADDLERS—*cont.*

AUTHORITY, Para. 12,476, L. of C., 1.12.1904.

Description and Number.	S.
Detail of Pannier—*cont.*	
Irons, pricking, 12 stitch	1
Irons, pricking, 7 „	1
Irons, pricking, 5 „	1
Irons, collar plugging	1
Knives, gauge, plough	1
Knives, half-round	1
Knives, head	1
Knives, trimming	1
Lead, punching, saddlers, 4-lb. pieces	1
Mallets, collar	1
Mallets, tinmans	1
Marlinespikes, steel, 9 inch	1
Needles, collar, 6½ inch	1
Needles, half-moon, 5½ „	1
Needles, half-moon, 4½ „	1
Needles, darning, 4 inch	6
Needles, harness	75
Needles, saddlers, sewing	50
Needles, saddlers, stitching	25
Palms, saddlers	1
Pincers, saddlers	pairs 1
Pliers, flat nose	„ 1
Punches, oval, No. 31	1
Punches, oval, „ 28	1
Punches, oval, „ 24	1
Punches, oval, „ 23	2
Punches, oval, „ 22	2
Punches, oval, „ 21	2
Punches, oval, „ 20	2
Punches, spring, 11 inch (with 7 cutters)	1
Rasps, shoemakers, 10 inch	1
Rules, G.S., 4-fold	1
Scissors, tailors	pairs 1
Screwdrivers, G.S., 6 inch	1
Shaves, saddlers	1
Stick, stuffing	1
Thimbles, tailors	2
Tools, edge, No. 2	1
Tools, edge, „ 3	1

Description and Number.	S.
Section No. 12.	
Stones, rub, scythe	1
The undermentioned materials taken from the supply allowed in Appendix X., Part I., of Equipment Regulations, will also be carried in the pannier with the tools when required.	
Section No. 6. *Articles for Repair.*	
Basils, brown, strained	1
Basils, brown, unstrained	1
Buckles, iron, roller, double, barred, 1¼ inch, curved	3
Buckles, iron, roller, double, 1¼ inch (head, collar)	3
Buckles, iron, roller, double, 1 inch	3
Buckles, iron, roller, double, ⅞ „	6
Buckles, iron, roller, single, 1¾ inch bow leg	3
Buckles, iron, roller, single, 1½ inch bow leg	3
Felt, brown (or numnah) cuttings lbs.	1
Hair, horse, saddlery „	3
Hides, brown, backs, collar	8
Rings, iron, 1¾ inch, slight	3
Serge, saddlers yards	1
Studs, wallet	6
Thread, flax, fine lbs.	8/16
Thread, whited brown „	4/16
Web, hemp, 3-inch (straining) yards	2
Section No. 8.	
Twine-quilting lbs.	½
Section No. 9.	
Wax, bees lbs.	4/16
Wax, black	4/16

TOOLS, FITTERS OR WHEELERS. R.H., R.F., & R.G. ARTILLERY.

No. 1 Set. (Carried in a Valise, Tool.)

Description and Number.	S.	Description and Number.	S.
Section No. 7.		**Section No. 7—*cont.***	
Callipers, 4 in. outside ... pairs	1	Handles, file, small	1
Chisels, cross cut, 7″ × ¼″ ...	1	Pliers, side cutting, 8 in., Mk IV. pairs	1
Chisels, hand, cold, ¾″ × 8″ ...	2	Punches, pin, ¼ in.	1
Chisels, firmer, coachmakers, 1 in.	1	Punches, pin, 3/16 in.	1
Drifts, brass, round, ⅜ in. ...	1	Punches, pin, ⅛ in.	1
Files, bastard, round, 10 inch...	1	Rules, A.A., 1-foot...	1
Files, regular cut, H.S.E., tanged, 12 in.	1	Scribers	1
Files, fine cut, H.S.E., tanged, 8 in.	1	Spokeshaves, 3¼ in.	1
Files, smooth, ½ round, 6 in. ...	1	Vices, hand, combination... ...	1
Hammers, fitters, 16 oz.	1	**Section No. 10.**	
Handles, file, large	1	Nails, assorted ... ... lbs.	1
Handles, file, middling	1	Screws, assorted ... ... „	1

No. 2 Set. (Carried in Bag, Tool, Wheelers.)

Description and Number.	S.	Description and Number.	S.
Section No. 7.		**Section No. 7—*cont.***	
Augers, screw, solid, wing eyed, 1½ in.	1	Augers, 16 in....	1
Augers, screw, solid, wing eyed, 1-in., 29 in. long	1	Augers, handles, 13½ in.	1
Augers, screw, solid, wing eyed, ⅞ in.	1	Screwdrivers, G.S., 14 in. ...	1

No. 3 Set. (Carried in Box, Mobilization Stores, No. 1.)

Description and Number.	S.	Description and Number.	S.
Section No. 7.		**Section No. 7—*cont.***	
Aprons, canvas, white	1	Holders, file, with handle, ½-round. 14 in.	1
Braces, carpenters, ratchet, with 24 bits	1	Holders, file, with handle, ½-round. 8 in.	1
Cans, oil, lubricating, small ...	1	Oilstones, carpenters	1
Drifts, steel, round, ½ in.... ...	1	Pencils, carpenters	2
Files, bastard, round, 6 in. ...	1	Planes, smoothing, G.S.	1
Files, regular cut, 14 in. ...	1	Pliers, side cutting, 8 in., Mk. IV., pairs	1
Files, ½-round 8 in.	1	Punches, carpenters, small ...	1
Files, saw, taper, second cut, single, 6 in.	1	Rules, smiths	1
Hammers, fitters, 8 oz.... ...	1	Screwdrivers, G.S., 6 in.... ...	1
Hammers, riveting, 24 ozs. ...	1	Sets, saw, hand	1
Handles, file, large	1	Spanners, adjustable, 11 in. ...	1
		Squares, fitters, 4 in.	1
		Stocks, drill, hand, Mk. II. ...	1

TOOLS, SADDLERS. R.H., R.F., & R.G. ARTILLERY.

No. 1 Set. (Carried in a Valise, Tool.)

Description and Number.	S.	Description and Number.	S.
Section No. 7.		Section No. 7—*cont.*	
Aprons, canvas, white	1	Knives, head	1
Awls, blades, harness, 3 in. ...	1	Marline spikes, steel, 9 in. ...	1
harness, $2\frac{3}{4}$,, ...	1	Needles, collar, $\frac{1}{2}$-moon, $5\frac{1}{2}$ in.	1
harness, $2\frac{1}{2}$,, ...	1	darning, 4 in.	2
harness, $2\frac{1}{4}$,, ...	1	harness...	25
harness, 2 ,, ...	1	saddlers, sewing ...	25
pannel, $5\frac{1}{4}$ in.	1	saddlers, stitching ...	10
Awls, handles, harness... ...	2	Palms, saddlers	1
Awls, handles, pannel	1	Pliers, flat nose ... ... pairs	1
Clams, saddlers ... ... pairs	1*a*	Punches, spring, 11 in.	1
Knives, half-round	1	Thimbles, tailors	1

a Strapped outside valise.

No. 2 Set. (Carried in Box, Mobilization Stores, No. 6.)

Number and Description.	S.	Number and Description.	S.
Section No. 7.		Section No. 7—*cont.*	
Awls, blades, buckling, 5 in. ...	6	Mallets, tinmans	2
buckling, 4 ,, ...	6	Needles, collar, $\frac{1}{2}$-moon, $6\frac{1}{2}$ in.	2
drawing	4	collar, $\frac{1}{2}$-moon, $4\frac{1}{2}$,,	2
garnishing, $2\frac{1}{4}$ in.	4	darning, 4 in.... ...	6
garnishing, 2 ,, ...	4	harness...	75
harness, 3 in. ...	3	saddlers, sewing ...	25
harness, $2\frac{3}{4}$,, ...	5	saddlers, stitching ...	20
harness, $2\frac{1}{2}$,, ...	5	Pincers, saddlers ... ... pairs	2
harness, $2\frac{1}{4}$,, ...	5	Punches, oval, No. 31	2
harness, 2 ,, ...	3	,, 28	2
pannel, 7 ,, ...	4	,, 24	2
pannel, $5\frac{1}{4}$,, ...	2	,, 23	4
Awls, handles, drawing ...	8	,, 22	4
Awls, handles, harness ...	2	,, 21	4
Awls, handles, pannel ...	6	,, 20	4
Bones, hollow	2	Rasps, shoemakers, 10 in. ...	2
Chisels, hand, cold, 3″ × 8″ ...	2	Rules, G.S., 4-fold	2
Claws, nail	2	Scissors, tailors ... ... pairs	2
Compasses, wing, 7 in. ... pairs	2	Screwdrivers, G.S., 6 in.... ...	2
Creases, double	2	Shaves, saddlers	2
Creases, single	2	Sticks, stuffing	2
Gimlets, common, No. 6	2	Thimbles, tailors	2
Hammers, riveting, 8 oz. ...	2	Tools, edge, No. 2	2
Hammers, saddlers	2	,, 3	2
Irons, pricking, 12 stitch ...	2	Section No. 10.	
Irons, pricking, 7 ,, ...	2	Padlocks, iron, 2 in.	1
Irons, pricking, 5 ,, ...	2	Section No. 12.	
Knives, gauge, plough... ...	2	Stones, rub, scythe	2
Knives, trimming	2		
Lead, punching, saddlers, 4 lb. pieces	2		

HOLDALLS, TOOL, SADDLERS, SETS.

Description and Number.			S.
Section No. 7.			
Holdalls, tool, saddlers			1
Awls, blades,	drawing		2
	garnishing	2¼ in. ...	2
		2 ,, ...	2
	harness	3 in. ...	1
		2⅞ ,, ...	2
		2½ ,, ...	2
		2¼ ,, ...	2
		2 ,, ...	2
	pannel, 7 in.		2
Awls, handles,	drawing ...		1
	harness... ...		3
	pannel		1
Clams, saddlers		pairs	1
Claws, nail		...	1
Compasses, wing, 7 in. ...		pairs	1
Hammers, riveting, 8 oz. ...		...	1
Knives,	half-round		1
	trimming		1

Description and Number.			S.
Section No. 7—*cont.*			
Marline spikes, steel, 9 in. ...			1
Needles,	collar, ½-moon,	6½ in.	1
		5½ ,,	1
		4½ ,,	1
	harness...		25
	saddlers, sewing ...		25
Palms, saddlers			1
Pliers, flat nose		pairs	1
Punches, spring, 11 in.			1
Rules, G.S., 4-fold...			1
Scissors, tailors, pairs			1
Shaves, saddlers			1
Thimbles, tailors			1
Section No. 12.			
Stones, rub, scythe			1

CHESTS, TOOL, FILLED. ARMAMENT ARTIFICERS. R.H. & R.F. ARTILLERY.

AUTHORITY, Paras. 14296 / 1.10.08; 14842 / 1.12.09; 15010 / 1.5.10; 15087 / 1.7.10; 15277 / 1.1.11; 15429 & 15430 / 1.5.11; 16099 / 1.10.12 & 16337 / 1.5.13 L. of C. & 54 / A.O.C. 313A & 54 / Artillery 4052

Description and Number.	S.
Section No. 7.	
Chest, tool, empty, No. 3	1
Aprons, canvas, white	2
Braces, ratchet, posts, 16 in., Mark II	1
Braces, ratchet, 9 in. drills, 12 in. drills	1
Braces, ratchet, 9 in. drills, twist, square taper, shank,	sets 1
⅝ in.	1
17/32 in.	1
½ ,,	1
7/16 ,,	1
⅜ ,,	1
Brushes, hair, flat, 1 in.	1
Callipers, pairs, 6 in.	1
5 ,,	1
4 ,, inside	1
Cans, oil, G.S.	1
lubricating, small	1
Chisels. cross cut, 8″×⅝″	1
7″×¼″	5
hand, cold, ¾″×8″	6
rivet head	1
smith, with hot	1
wood handle, cold	1
Cramps, fitters, 5 in.	2
Dividers, spring, 6 in., Mark II	1
Drifts, brass, round, 1 in.	1
¾ ,,	1
½ ,,	2
⅜ ,,	2
steel, round, 1 1/16 in.	1
9/16 ,,	1
7/16 ,,	1
5/16 ,,	1
Drills, twist	sets 1
Files, bastard, flat, 6 in.	3
half-round, 6 in.	2
knife, 6 in.	2
round, 14 in.	2
12 ,,	2
10 ,,	2
8 ,,	2
6 ,,	2

Description and Number.	S.
Section No. 7—*cont.*	
Files, regular cut, bastard, square, 12 in.	2
8 ,,	2
warding, 4 in.	2
cut on one side, 3½ ,,	2
3 ,,	2
hand, safe edge, tanged, 14 in.	2
12 ,,	2
half-round, 14 in.	1
12 ,,	1
10 ,,	1
8 ,,	1
dead smooth, flat, 12 in.	1
half-round, 4 in.	1
hand, safe edge, 4 in.	1
fine cut, hand, safe edge, tanged, 14 in.	1
12 ,,	1
10 ,,	1
8 ,,	2
half-round, 12 ,,	1
10 ,,	1
8 ,,	1
saw, taper, 6 in.	2
2nd cut, single, 4 ,,	2
3 ,,	2
2nd cut, hand, safe edge, 6 ,,	1
4 ,,	1
smooth, flat, 12 in.	1
6 ,,	1
half-round, 12 in.	1
8 ,,	2
6 ,,	2
hand, 8 ,,	2
safe edge, 4 ,,	1
Flatters, smiths, Mark II	1
Fullers, bottom	1
smiths, F.S., top	1
Gauges, feeler, 8-blade, Mark II	1
Hammers, fitters, 48-ozs., copper	1
24 ,,	1
16 ,,	1
8 ,,	1

CHESTS, TOOL, FILLED. ARMAMENT ARTIFICERS. R.H. & R.F. ARTILLERY—*cont.*

AUTHORITY, Paras. 14296/1.10.08 14842/1.12.09 15010/1.5.10 15087/1.7.10 15277/1.1.11 15429 & 15430/1.5.11 16099/1.10.12 & 16337/1.5.13 L. of C. & 54/A.O.C./313A & 54/Artillery/4052

Description and Number.	S.
Section No. 7—*cont.*	
Hammers, riveting, boilermakers, 2½-lbs.	1
Hammer handles, No. 2	1
Hammer handles, „ 5	1
Hammer handles, „ 6	2
Hammer handles, „ 7	1
Handles, file, large	5
Handles, file, middling	5
Handles, file, small	4
Holdalls, tool, armament artificers	1
Holders, file, with handle, half-round, 14 in.	1
Holders, file, with handle, half-round, 12 „	1
Holders, file, with handle, half-round, 10 „	1
Holders, file, with handle, half-round, 8 „	1
Irons, soldering, tinmans, large	1
Lamps, brazing, 1 pint	1
Levels, spirit, adjustable	1
Mallets, tinmans	1
Oil stones, carpenters	1
Plates, screws, B.A. thread,	sets 1
Pliers, round nose	pairs 1
Pliers, side-cutting, 8 in., Mark II, pairs	1
Pliers, side-cutting, 8 in., Mark II, cutters	1
Punches, centre, 4 in.	2
Punches, pin, ¼ „	1
Punches, pin, 1/16 „	1
Punches, pin, ⅛ „	1
Punches, round, ½″ × 10″	1
Punches, smiths, cold	1
Rules, armament artificers, 1 in.	1
Saws, hack, 12 in.	1
Saws, hack, blades, 12 in.	12
Screw-drivers, A.A., 9 in. (with tommy)	1
Screw-drivers, G.S., 6 in.	1
Screw-drivers, watchmakers, 5/16 in.	1

Description and Number.	S.
Section No. 7—*cont.*	
Spanners, adjustable, 15 in.	1
Spanners, adjustable, 11 „	1
Spanners, A.A., double-ended, ⅜ in. and ⅝ in.	1
Scribers	1
Shears, tinmans, snip	pairs 1
Snaps, hand, riveting, ⅜ in.	1
Snaps, hand, riveting, 5/16 „	1
Snaps, hand, riveting, ⅜ „	1
Snaps, riveting, rod, ⅜ in.	1
Squares, fitters, 8 in.	1
Squares, fitters, 4 „	1
Stocks, breast	1
Stocks, drill, hand, Mark II	1
Straightedges, steel, 2 ft.	1
Tongs, pairs, smiths, forebit	1
Tongs, pairs, smiths, hollow bit	1
Tongs, pairs, wheelers, fitters	1
Vices, bench, saddletreemakers	1
Vices, hand, combination	1
Wrenches, adjustable, 9 in.	1
Section No. 9.	
Cloth, emery, No. F.	sheets 12
Resin, black,	lbs. ¼
Section No. 13.	
Cloths, sponge	6
Leather, chamois	1

BAG, VICE (RANGE-FINDING ARTIFICERS), FILLED.

Description and Number.	S.
Weedon Section.	
Burnishers, flat	1
Burnishers, oval	1
Burnishers, triangular	1
Screwdrivers, armourers, small	1
Section No. 3.	
Solder, tinmans, soft ... lbs.	1
Section No. 7.	
Bags, vice	1
Blowpipes, 8 in.	1
Brushes, plate	2
Brushes, watchmakers	2
Callipers, 5 in. ... pairs	1
Cans, oil, lubricating, small*	1
Dividers, spring, 6 in.	1
Drills, morse, twist ... sets	1
Eyeglasses	1
Files, bastard, round, 6 in.	1
Files, dead, half-round, 6 in.	1
Files, 2nd cut, hand, safe edge, 6 in.	1
Files, dead, square, 8 in.	1
Files, smooth, flat, 6 in.	1
Files, smooth, half-round, 4 in.	1
Files, smooth, hand, safe edge, 4 in.	1
Files, smooth, half-round, 6 in.	1
Files, smooth, hand, safe edge, 8 in.	1
Files, smooth, hand, safe edge, ...	2
Files, smooth, round, 6 in.	1
Files, smooth, round, 3 in.	1
Files, smooth, square, 6 in.	1
Files, smooth, square, 4 in.	1
Files, smooth, 3-square, 4 in.	1
Gravers, turners, $\frac{5}{32}$ in.	1
Gravers, turners, $\frac{3}{32}$ in.	1
Hammers, fitters, 8 ozs.	1
Handles, file, small	1
Irons, soldering, telegraph mechanics	1
Knives, clasp	1

Description and Number.	S.
Section No. 7—*cont.*	
Nippers, end-cutting, G.S., pairs	1
Pincers, carpenters' ... "	1
Pliers, flat nose	1
Pliers, round nose	1
Pliers, side-cutting, 7 in.	1
Punches, centre, 4 in.	1
Rules, armament artificers, 1 ft.	1
Saws, cutting metal, 6 in.	1
Saws, keyhole, blades	1
Saws, keyhole, pads	1
Scissors, laboratory ... pairs	1
Screwdrivers, G.S. 6 in.	1
Screwdrivers, G.S. 4 in.	1
Spanners, McMahon, 9 in.	1
Squares, fitters, 4 in.	1
Stocks, drill, hand, Mk. II	1
Oilstones, telegraph mechanics	1
Tongs, watchmakers, bull-nose pairs	1
Tools, screw-cutting, B.A. thread G.S., ... sets	1
Tools, watchmakers, files, pivoting "	1
Tools, watchmakers, nippers	1
Tools, watchmakers, screwdrivers sets	1
Tools, watchmakers, tweezers	1
Vices, hand, 8 ozs.	1
Vices, pin	1
Section No. 9.	
Compound, Chatterton's ... ozs.	4
Section No. 13.	
Leather, chamois	1
Section No. 28.	
Solder, silver ... ozs.	2
Section No. 29.	
Lamps, spirit, telegraph mechanics	1
Pegwood, ... bundles	1
Tools, electricians ... sets	1

* Amended *vide* para. 14485 L. of C. 1.3.09.
† Amended *vide* para. 15010 L. of C. 1.5.10.
‡ Amended *vide* §15430 L. of C. 1.5.11.

BAG, VICE (ARMAMENT ARTIFICERS), FILLED.

Description and Number.		Description and Number.	
Bags, vice	1	Hammers, fitters, 8 ozs.	1
Brushes, plate	2	Knives, clasp	1
Brushes, watchmakers	2	Lamp, spirit, telegraph mechanics	1
Burnishers, flat	1	Leathers, chamois...	1
Burnishers, oval...	1	Nippers, end-cutting, G.S., 6 in.	1
Burnishers, triangular	1	Pegwood ... ... bundles	1
Callipers, 5 in. ... ... pairs	1	Pincers, carpenters ... pairs	1
Compound, Chatterton's ... ozs.	4	Pipes, blow, 8 in., Mark II ...	1
Dividers, spring, 6 in. ... pairs	1	Pliers, flat nose ... ... pairs	1
Drills, Morse, twist ... sets	1	Pliers, round nose ... „	1
Drivers, screw, G.S. 6 in. ...	1	Pliers, side-cutting, 7 in. „	1
Drivers, screw, G.S. 4 „ ...	1	Punches, centre, 4 in.	1
Drivers, screw, armourers, small... ...	1	Rules, armament artificers, 1 foot	1
Eyeglasses	1	Saws, cutting metal, 6 in. ...	1
Files, bastard, hand, safe edge, 8 in.	1	Saws, keyhole, blades ...	1
Files, rough, round, 6 inch... ...	1	Saws, keyhole, pads	1
Files, second cut, half-round, 6 in. ...	1	Scissors, laboratory ... pairs	1
Files, second cut, one safe side, square, taper, 8 in. ...	1	Solder, silver ... ... ozs.	2
Files, second cut, hand, safe edge, 6 in....	1	Solder, tinmans ... lbs.	1
Files, dead smooth, flat, 6 inch ...	1	Spanners, McMahon's, 9 in., Mark II...	1
Files, dead smooth, half-round, 4 in....	1	Squares, fitters	1
Files, dead smooth, hand, safe edge, 4in.	1	Stones, oil, telegraph mechanics	1
Files, smooth, half-round, 6 in....	1	Tips, oil	1
Files, smooth, pillar, 3 in.	1	Tongs, watchmakers, bull-nose pairs	1
Files, smooth, round, 6 in.	1	Tools, watchmakers, electricians, large ... sets	1
Files, smooth, round, 3 „	1	Tools, watchmakers, screw-cutting, British Association Standard, General Service ... sets	1
Files, smooth, hand, safe edge, 6 in. ...	1	Tools, watchmakers, drills, hand	1
Files, smooth, hand, safe edge, 3 „ ...	1	Tools, watchmakers, drivers, screw sets	1
Files, smooth, square, 6 in.	1	Tools, watchmakers, nippers...	1
Files, smooth, square, 4 „	1	Tools, watchmakers, tweezers ... pairs	1
Files, smooth, 3-square, 3 in.	1	Vices, hand, 8 oz.	1
Files, pivoting ... ... sets	1	Vices, pin...	1
Irons, soldering, telegraph mechanics	1		
Gravers, turners $\frac{5}{32}$ in. ...	1		
Gravers, turners $\frac{7}{32}$ „ ...	1		

ROYAL HORSE, ROYAL FIELD AND ROYAL GARRISON ARTILLERY.

TOOLS, TINMANS, SETS.

(Carried in Box, Mobilization Stores, No. 1.)

Description and Number.		Description and Number.	
Section No. 7.	S.	Section No. 3.	S.
Groovers, tinmans, small... ...	1	Solder, tinmans, soft ...	lbs. 1½
Irons, soldering, tinmans, large	1	Section No. 13.	
Mallets, tinmans	1	Cloths, sponge	4
Shears, tinmans, Scotch ... pairs	1		

TOOLS, FORGE, SETS.

(Carried in Box, Mobilization Stores, No. 1.)

Description and Number.		Description and Number.	
Section No. 7.	S.	Section No. 7—*cont.*	S.
Chisels, farriers, handled ...	2	Tongs, farriers, turning, pairs { large... ...	1
Hammers, farriers, { turning ...	1	medium ...	1
sledge, 9½-lbs. ...	1	small... ...	1
Stamps, farriers, ...	2	Section No. 10.	
		Nails, horse shoe, assorted	lbs. 3

TOOLS, SHOEING, SETS.

(Carried in a Valise, Tool.)

Description and Number.		Description and Number.	
Section No 7.	S.	Section No. 7—*cont.*	S.
Apron, basil, brown	1		
Buffers, farriers	1	Pincers, farriers ... ... pairs	1
Hammers, farriers, shoeing ...	1	Pritchel, farriers...	1
Knives, { drawing, farriers ...	1	Rasps, farriers, 16 in.	1
{ searching, farriers ...	1	Stones, rag, farriers	1

ALL SERVICES (EXCEPT R.H., R.F., & R.G. ARTILLERY).

BAGS, TOOLS, FARRIERS, FILLED, SETS.

Description and Number.		Description and Number.	
Section No. 7.	S.	Section No. 7—*cont.*	S.
Apron, basil, brown	1	Pincers, farriers ... ... pairs	1
Bags, tool, farriers	1	Pritchels, farriers...	1
Buffers, farriers	1	Rasps, farriers, 16 in.	2
Hammers, farriers shoeing ...	1	Stones, rag, farriers	1
Knives, drawing, farriers ...	2		
Knives, searching, farriers ...	1		

TOOLS, SCREW-CUTTING, BRASS AND COPPER TUBE, MARK I.

CHESTS, FILLED, $\frac{3}{4}$-INCH TO $\frac{1}{4}$-INCH.

AUTHORITY, Paras. $\frac{10862}{1.2.02}$ L. of C.

Description and Number.			Description and Number.		
Tools, screw-cutting, brass and copper tube, Mark I,		S.	Tools, screw-cutting, brass and copper tube, Mark I,		
	chest, empty, $\frac{3}{4}$ in. to $\frac{1}{4}$ in.	1		taps, $\frac{3}{4}$ in. taper	1
	dies, $\frac{3}{4}$ in.	1		taps, $\frac{3}{4}$ in. plug	1
	dies, $\frac{5}{8}$ "	1		taps, $\frac{5}{8}$ " taper	1
	dies, $\frac{1}{2}$ "	1		taps, $\frac{5}{8}$ " plug	1
	dies, $\frac{7}{16}$"	1		taps, $\frac{1}{2}$ " taper	1
	dies, $\frac{3}{8}$ "	1		taps, $\frac{1}{2}$ " plug	1
	dies, $\frac{5}{16}$"	1		taps, $\frac{7}{16}$" taper	1
	dies, $\frac{1}{4}$ "	1		taps, $\frac{7}{16}$" plug	1
	guides, $\frac{3}{4}$ "	1		taps, $\frac{3}{8}$ " taper	1
	guides, $\frac{5}{8}$ "	1		taps, $\frac{3}{8}$ " plug	1
	guides, $\frac{1}{2}$ "	1		taps, $\frac{5}{16}$" taper	1
	guides, $\frac{7}{16}$"	1		taps, $\frac{5}{16}$" plug	1
	guides, $\frac{3}{8}$ "	1		taps, $\frac{1}{4}$ " taper	1
	guides, $\frac{5}{16}$"	1		taps, $\frac{1}{4}$ " plug	1
	guides, $\frac{1}{4}$ "	1		wrenches, large	1
	stocks, large	1		wrenches, medium	1
	stocks, small	1		wrenches, small	1

LIST OF TOOLS, AND SPARE PARTS OF No. 7 DIAL SIGHTS, FOR USE OF R.F. ARTIFICERS.

AUTHORITY, $\frac{121}{\text{Stores.}}{1096}$

Description and Number.	S.
Section No. 3.	
Steel:—	
Rods, bright, Nos. E 27, 32, 42, 49 ... ... of each lbs.	½
Wire, ordinary:—	
Brass, Nos. 3, 6, 9, 11, 13, 15 ... ... of each lbs.	1
Section No. 7.	
Bags, vice, R.F. artificers, filled	1
Broaches, telegraph mechanics, blades 1 to 60 set	1
Broaches, telegraph mechanics, handles	6
Brushes—Hair, flat, ½ in. and 1 in. ... ... of each	1
Lathes, watch-makers, arms	1
Lathes, watch-makers, mandrils ...	1
Lathes, watch-makers, wheels	1
Screwdrivers, watchmakers, ¼ in.	1
Screwdrivers, watchmakers, $\frac{3}{16}$ in.	1
Screwdrivers, watchmakers, $\frac{1}{8}$ in.	1
Tools, watchmakers—	
Files, Geneva, round	2
Files, Geneva, square	2
Files, Geneva, 3-square	2
Files, Geneva, cylinder notch ...	2
Files, Geneva, dovetail	2
Files, Geneva, ratchet	2
Files, screw head, Nos. 1 and 0 ... ... of each	6
Vices—Bench, parallel, 12 lbs. ...	1
Section No. 9—A.	
Paper, emery, Nos. 0, 1, 2, 3 sheets	24
Sticks, emery, Nos. 60, 0, 1, 2 of each	6
Methylated spirit, industrial gall.	1
Section No. 15—B.	
Boxes, R.F. artificers, empty	1
Boxes, small, wooden, "A" ...	6
Boxes, " " "D" ...	6
Boxes, " " "E" ...	1
Boxes, " " "G" ...	1

Description and Number.	S.
Section No. 15—B—*cont.*	
Boxes, R.F. artificers—	
Screws, brass, B.A.—	
Capstan-headed, No. 4, ⅜ in. ...	6
Capstan-headed, " 6, $\frac{9}{32}$ " ...	6
Capstan-headed, " 6, $\frac{1}{4}$ " ...	20
Capstan-headed, " 8, 1¼ " ...	50
Cheese-headed, No. 0, 1 in.	12
Cheese-headed, " 2, $\frac{19}{32}$ in.	12
Cheese-headed, " 4, $\frac{3}{16}$ " large head	50
Cheese-headed, " 4, $\frac{3}{16}$ " small "	50
Cheese-headed, " 6, $\frac{9}{32}$ " large "	50
Cheese-headed, " 6, $\frac{9}{32}$ " small "	50
Cheese-headed, " 8, $\frac{5}{16}$ " large "	50
Cheese-headed, " 8, $\frac{5}{16}$ " small "	50
Cheese-headed, " 10, $\frac{3}{8}$ "	50
Countersunk headed—	
No. 0, 1¼-in.	12
No. 2, $\frac{19}{32}$ "	12
No. 8, $\frac{5}{16}$ "	50
No. 10, $\frac{3}{8}$ "	50
Screws, iron, B.A., cheese-headed—	
No. 4, $\frac{5}{16}$ in.	50
" 6, $\frac{9}{32}$ in.	50
Screws, iron, B.A., countersunk headed—	
No. 8, ½ in.	50
Tools for repair of No. 7 dial sight, Nos. 1 to 15 ... sets	1
Wrench, adjusting, No. 7 dial sight	1
Spare parts of No. 7 Dial Sight.	
Cross head	1
Pinion, cross head...	1
Nut, cross head	1
Set of 3 pins, keep, micrometer head	1
Springs, pinion	6
Rings, milled	6
Cap, clamping micrometer head...	1
Drums, graduated...	2
Collar, clamping	1

LIST OF TOOLS, AND SPARE PARTS OF No. 7 DIAL SIGHTS, FOR USE OF R.F. ARTIFICERS—*cont.*

121

AUTHORITY, Stores. 1096

Description and Number.	Description and Number.
Section No. 15—B—*cont.*	Section No. 15—B—*cont.*
Spare Parts—*cont.* S.	Spare Parts—*cont.* S.
Washers, spring, micrometer head 2	Collar, actuating worm spindle ... 2
Spindle, worm 1	Reader, micrometer, right and left ... ... of each 2
Washer, spindle, worm 1	Window, diaphragm 2
Toothed segment 1	Pins, keep, split, nut, plug, supporting pillar 12
Pin, securing toothed segment ... 1	Rings, milled, carrier No. 2 ... 4
Washer, spring, worm spindle ... 1	Drums, graduated, carrier No. 2, right and left ... of each 2
Steady pins... 12	Nut securing graduated drum, carrier No. 2 2
Eye guards, dermatine 12	Rings, milled, micrometer head upper prism holder 6
Eye lenses 8	Drums, graduated micrometer head, upper prism holder ... 3
Screws, securing dial plate ... 60	
„ „ deflection plate 12	
„ „ case, upper prism 6	N.I.V.
Screws, securing bracket, worm wheel 6	Vaseline, pure ... ... lbs. 3
Screws, grub, assorted 60	Hartley's standard dead lacquer bottles 2
„ adjusting lower prism ... 6	
„ safety, lower prism ... 6	
Washers, spring, carrier No. 2 ... 25	
Plate, reader, dial plate 2	
„ securing, reader, dial plate 2	

TOOLS, SCREW CUTTING, BOLT AND NUT (BRITISH STANDARD WHITWORTH SCREW THREAD, MARK III.

Description and Number.	S.	Description and Number.	S.
"A" CHESTS, FILLED, 1½ INCH TO 1⅛ INCH.			
Chest "A," empty, 1½ inch to 1⅛ inch	1	Taps, 1⅜ inch, taper	1
Clip piece	1	Taps, 1⅜ inch, second	1
Dies (to fit Stock "A"), sets, 1½ inch	1	Taps, 1⅜ inch, plug	1
Dies (to fit Stock "A"), sets, 1⅜ inch	1	Taps, 1¼ inch, taper	1
Dies (to fit Stock "A"), sets, 1¼ inch	1	Taps, 1¼ inch, second	1
Dies (to fit Stock "A"), sets, 1⅛ inch	1	Taps, 1¼ inch, plug	1
Spanners "A"	1	Taps, 1⅛ inch, taper	1
Stock "A"	1	Taps, 1⅛ inch, second	1
Taps, 1½ inch, taper	1	Taps, 1⅛ inch, plug	1
Taps, 1½ inch, second	1	Wrench "A"	1
Taps, 1½ inch, plug	1		
"B" CHESTS, FILLED, 1 INCH TO ⅝ INCH.			
Chest "B," empty, 1 inch to ⅝ inch	1	Taps, ⅞ inch, taper	1
Dies (to fit stock "B"), sets, 1 inch	1	Taps, ⅞ inch, second	1
Dies (to fit stock "B"), sets, ¹⅞ "	1	Taps, ⅞ inch, plug	1
Dies (to fit stock "B"), sets, ¾ "	1	Taps, ¾ inch, taper	1
Dies (to fit stock "B"), sets, ⁵⁄₈ "	1	Taps, ¾ inch, second	1
Spanners "B"	1	Taps, ¾ inch, plug	1
Stock "B"	1	Taps, ⅝ inch, taper	1
Taps, 1 inch, taper	1	Taps, ⅝ inch, second	1
Taps, 1 inch, second	1	Taps, ⅝ inch, plug	1
Taps, 1 inch, plug	1	Wrenches "B"	1
			1
"C" CHESTS, FILLED, ½ INCH TO ⁵⁄₁₆ INCH, SETS			
Chests, empty, "C," ½ in. to ⁵⁄₁₆ in.	1	Taps, ⁷⁄₁₆ inch, taper	1
Dies, (to fit Stock "C"), sets, ½ inch	1	Taps, ⁷⁄₁₆ inch, second	1
Dies, (to fit Stock "C"), sets, ⁷⁄₁₆ "	1	Taps, ⁷⁄₁₆ inch, plug	1
Dies, (to fit Stock "C"), sets, ⅜ "	1	Taps, ⅜ inch, taper	1
Dies, (to fit Stock "C"), sets, ⁵⁄₁₆ "	1	Taps, ⅜ inch, second	1
Spanners "C"	1	Taps, ⅜ inch, plug	1
Stock "C"	1	Taps, ⁵⁄₁₆ inch, taper	1
Taps, ½ inch, taper	1	Taps, ⁵⁄₁₆ inch, second	1
Taps, ½ inch, second	1	Taps, ⁵⁄₁₆ inch, plug	1
Taps, ½ inch, plug	1	Wrench "C"	1
"D" CHESTS, FILLED, ¼ INCH TO ¹⁄₁₆ INCH, SETS.			
Chests, empty, "D," ¼ inch to ¹⁄₁₆ inch	1	Taps, ⁹⁄₃₂ inch, taper	1
Dies (to fit Stock "D") sets, ¼ inch	1	Taps, ⁹⁄₃₂ inch, second... ...	1
Dies (to fit Stock "D") sets, ⁹⁄₃₂ "	1	Taps, ⁹⁄₃₂ inch, plug	1
Dies (to fit Stock "D") sets, ⁷⁄₃₂ "	1	Taps, ⁵⁄₃₂ inch, taper	1
Dies (to fit Stock "D") sets, ⅛ "	1	Taps, ⁵⁄₃₂ inch, second... ...	1
Dies (to fit Stock "D") sets, ⁵⁄₃₂ "	1	Taps, ⁵⁄₃₂ inch, plug	1
Dies (to fit Stock "D") sets, ¹⁄₁₆ "	1	Taps, ⅛ inch, taper	1
Holders, tap...	1	Taps, ⅛ inch, second... ...	1
Plate screw (to cut sizes ³⁄₃₂ and ¹⁄₁₆ inch)	1	Taps, ⅛ inch, plug	1
Spanners "D"	1	Taps, ³⁄₃₂ inch, taper	1
Stock "D"	1	Taps, ³⁄₃₂ inch, second... ...	1
Taps, ¼ inch, taper	1	Taps, ³⁄₃₂ inch, plug	1
Taps, ¼ inch, second	1	Taps, ¹⁄₁₆ inch, taper	1
Taps, ¼ inch, plug	1	Taps, ¹⁄₁₆ inch, second... ...	1
Taps, ⁹⁄₃₂ inch, taper	1	Taps, ¹⁄₁₆ inch, plug	1
Taps, ⁹⁄₃₂ inch, second	1	Wrenches, "D"	1
Taps, ⁹⁄₃₂ inch, plug	1		

TOOLS, SCREW CUTTING, IRON AND STEEL TUBE.

(BRITISH STANDARD PIPE THREAD.)

$1\frac{1}{2}$ INCH TO $\frac{1}{4}$ INCH, CHESTS, FILLED, SETS.

Description and Number.	S.	Description and Number.	S.
Chests, empty	1	Taps, $1\frac{1}{2}$ inch, taper	1
Dies, sets, $1\frac{1}{2}$ inch	1	$1\frac{1}{2}$ inch, plug	1
$1\frac{1}{4}$,, ...	1	$1\frac{1}{4}$,, taper	1
1 ,, ...	1	$1\frac{1}{4}$,, plug	1
$\frac{3}{4}$,, ...	1	$\frac{3}{4}$,, taper	1
$\frac{5}{8}$,, ...	1	$\frac{3}{4}$,, plug	1
$\frac{1}{2}$,, ...	1	$\frac{5}{8}$,, taper	1
$\frac{3}{8}$,, ...	1	$\frac{5}{8}$,, plug	1
$\frac{1}{4}$,, ...	1	$\frac{1}{2}$,, taper	1
Stocks, large	1	$\frac{1}{2}$,, plug	1
small	1	$\frac{3}{8}$,, taper	1
Taps, $1\frac{1}{2}$ inch, taper	1	$\frac{3}{8}$,, plug	1
$1\frac{1}{2}$ inch, plug	1	$\frac{1}{4}$,, taper	1
$1\frac{1}{4}$,, taper	1	$\frac{1}{4}$,, plug	1
$1\frac{1}{4}$,, plug	1	Tommies, 9-inch	1
		6 ,, ...	1
		Wrenches, large	1
		small	1

TOOLS, SCREW CUTTING, BOLT AND NUT.

(BRITISH STANDARD WHITWORTH SCREW THREAD.)

R.A. FIELD, CHESTS, FILLED, SETS.

Description and Number.	S.	Description and Number.	S.
Chest, empty	1	*Taps, $\frac{1}{2}$ inch, plug	1
Plates, screw, large	1	$\frac{1}{2}$ inch, taper	1
small	1	$\frac{1}{2}$ inch, second ...	1
*Taps, $\frac{3}{4}$ inch, plug	1	$\frac{5}{8}$,, plug	1
$\frac{3}{4}$ inch, taper	1	$\frac{5}{8}$,, taper	1
$\frac{3}{4}$ inch, second ...	1	$\frac{5}{8}$,, second ...	1
$\frac{5}{8}$,, plug	1	Wrenches, large	1
$\frac{5}{8}$,, taper	1	small	1
$\frac{5}{8}$,, second ...	1	†Tip, oil	1

* Tools, screw cutting, bolt and nut, Mark III taps will be issued when the above taps require replacement.

† Tips, oil, page 156, Vocab., 1909, are identical with tips, oil, as above; and when stock is exhausted will be replaced by "Cans, oil, lubricating, small."

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